Mycology

N.A.A.S.

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QUARTERLY REVIEW

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LONDON: HIS MAJESTY'S STATIONERY OFFICE: 1951

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July 2, 1951

QUALEM INTER ANTIQUOS rerum rusticarum scriptores constat fuisse Magonem Carthaginiensem, talem inter nostros fama invidia immunis professorem hunc Caledonium et Oxoniensem esse proclamat. Quicquid enim ad agri Britannici culturam, cuiuscunque regionis, attinet, omnia penitus intelligit scriptisque doctissimis exposuit. Felix quidem patria nostra quae inter belli angustias, cum de annona ceteroque victu laboraretur, huius consilio domi forisque niti poterat, bis felix qui bello confecto per pacis angustias vix minus artas eodem consilio non caruit. Universitatum studia umbratica posse aliquid in usum vitae conferre laetamur ; et his diebus, cum praesens haec Regia Societas nos admonet quantum agricolis nostris debeamus, iuvat etiam virum academicum palam honorare cui ea ipsa tantum debeat, non solum ceteroquin rerum rusticarum sed suorum etiam annalium scriptori.

Duco ad vos Equitem Auratum, Excellentissimi Ordinis Imperii Britannici Commendatorem, Cruce Militari ornatum

IACOBUM ANDERSON SCOTT WATSON

TRANSLATION

Just as the ancient writers on rural matters were in agreement concerning Mago of Carthage, so the writers of our own times proclaim the Professor of Scotland and Oxford free of all disparagement. He thoroughly understands everything which is connected with British agriculture in no matter what region and expounds it in most learned works.

Happy indeed is our country to have been able during the straits of war, when there was anxiety about our corn supply and food in general, to rely at home and abroad on this man's counsel, twice happy after the war, through the scarcely less constricted straits of peace, to have continued to receive that same counsel.

We are glad that the sheltered studies of universities can contribute something to practical life ; and in these days, when the presence of this Royal Society reminds us of how much we owe to our farmers, we are pleased to do public honour to an academic man to whom it owes so much itself, not only as a writer on agriculture, but also as its own historian.

ARTICLES

DEVELOPMENT OF THE POTATO CERTIFICATION SCHEME FOR ENGLAND AND WALES

J. R. Owen

National Agricultural Advisory Service, Eastern Province

The first part of the story of the Potato Certification Scheme resolves itself into an account of an effort made during the latter part of the first world war to combat Wart Disease, one of the worst diseases of potatoes, which became very prevalent in the northern and western counties during this period and later gained world-wide notoriety.

Wart Disease was known to have existed in certain localities as far back as 1893 or even earlier, but it was not until 1901 that it was brought to the notice of the then Board of Agriculture. Three years later the Board issued a leaflet on the disease and, in view of the part that immune varieties were to play later in its control, it is of special interest today that this leaflet mentions that three varieties, namely, Snowdrop, Conquest, and Main Crop, had escaped infection while other varieties grown on the same land succumbed to the disease. In 1908 Wart Disease was scheduled as a notifiable disease under the Destructive Insects and Pests Acts, 1877 to 1907, and thus it became necessary for all occupiers of land to notify the Board of any outbreaks. For the next few years numerous experiments were conducted to ascertain the effects of fungicides on the disease, but although some of these gave good results where infection was light, they were found to be practically useless where the soil was heavily infected.

Fortunately, however, for the potato-growing industry, it was observed by many growers whose land had been badly infected that several varieties besides those already mentioned were resistant. In order to confirm this, the Board carried out in 1909 a series of trials at the Harper Adams Agricultural College. The results of these trials proved that the information obtained from the growers was substantially correct and that some varieties were immune from the disease.

During the succeeding years the disease spread so rapidly that it became a serious danger to the industry. It occurred not only in areas known for several years to be infected, but in several new localities, and it became necessary for the Board to take action against many occupiers for failure to report its presence. In 1911 the Board published a list of immune varieties, but supplies of these were so scarce that most growers still planted non-immune varieties on infected land.

In Lancashire and Cheshire potato growing is an important branch of the farming industry, and it was in these counties that the disease was most rapidly increasing and causing serious losses. It was therefore decided in 1915 to carry out a series of trials at some convenient centre in that district. The farm of the Ormskirk Poor Law Institute was known to be badly infected with the disease, and the Farm Committee placed at the disposal of the Board such land as might be required for experimental purposes. Trials were started in 1915, and in the course of the next few years several hundred varieties were tested and approximately a third proved to be immune from the disease. In 1918 a complete alphabetical list of all varieties tested, and classified as immune, non-immune and of doubtful immunity, was published, and copies sent to all interested. The Board also tested a number of varieties at 36 other centres during 1917 and 1918.

Provision of Immune Seed

In 1918 an Order (Wart Disease of Potatoes Order of 1918) was made prohibiting the planting of susceptible varieties in areas scheduled as " infected areas ". This Order also prescribed that except where the sale was to a dealer in seed potatoes, immune varieties could be sold only by persons holding a licence from the Board. In consequence of this, the Board felt it necessary to take steps to secure sufficient supply of seed of immune varieties at a reasonable price and to ensure that occupiers in infected areas could be supplied with seed reasonably free from " rogues ". Arrangements were made with certain contractors in Scotland to grow during 1918 the following immune varieties : *Early*—Edzell Blue ; *Second Early*—King George, Ally and Great Scot ; *Maincrop*—Tinwald Perfection, Lochar, Kerr's Pink, Dominion and Majestic.

Arrangements were also made for the distribution of the seed from these crops for planting in infected areas in 1919. The crops were grown under the personal supervision of the Board's Inspectors and were carefully " rogued ". The Inspectors also supervised the dressing of the " seed " from the " ware ".

The efficacy of the regulation enforcing the planting in infected areas of immune varieties depended entirely on the purity of the " seed " used. The presence of rogues was bound to perpetuate the risk of infection and moreover to weaken the faith of growers in immune varieties. The practicability of carrying out a scheme of inspection of crops during the growing stage was carefully considered by the Board after consultation with officers of the Board of Agriculture for Scotland and the Department of Agriculture and Technical Instruction for Ireland, who undertook to carry out similar schemes in their respective countries. The method of inspection and the minimum standard of purity on which a certificate should be issued were carefully considered and prescribed. Notices were then published in the press urging growers of immune varieties in England and Wales to

apply for the inspection of their crops in 1918. Some 600 applications were received. Over 4,000 acres of potatoes were actually examined and only 350 acres ultimately fell below the standard prescribed for the issue of certificates.

In all cases where the Inspectors were satisfied with the crop, a certificate was issued to the effect that the potatoes examined were, to the Inspector's knowledge and belief, of the immune variety specified, true to type and reasonably free from rogues. By the Seed Potatoes Order of 1918, issued by the Food Controller, it became obligatory for the vendor to quote the number of the certificate on the invoice for all sales of inspected seed.

The possession of a certificate greatly facilitated the issue of the licence to sell immune seed retail, but the inspections carried out by no means covered the whole of the acreage of immune varieties and a number of applications were received for licences to sell uninspected seed. In such cases, where possible, an examination of the tubers was made. This method (i.e., inspection of tubers) enabled the Board to stop the sale of seed that was badly mixed, but it was not regarded as entirely satisfactory as it is never possible to determine the variety with certainty unless the crop is inspected whilst growing.

Thus a Certification Scheme was evolved to secure for growers an adequate supply of seed potatoes of immune varieties, reasonably free from rogues, which could be planted on infected land with comparative safety.

In spite, however, of the efforts made to arrest the spread of the disease, many new cases occurred in widely separated parts of the country between the years 1918 and 1923. In 1923 the Ministry of Agriculture issued a new Order (The Wart Disease of Potatoes Order, 1923), the chief object of which was to arrest the spread of the disease and secure that growers would be able to obtain seed potatoes free from infection. The chief provisions of this Order were:

(i) that presence of the disease be reported to the Ministry;
(ii) that potatoes visibly affected with the disease could not be sold for any purpose;
(iii) that on land on which the disease had been known to exist the only potatoes that could be planted were those stocks of immune varieties which had been inspected whilst growing and certified as being true to type;
(iv) that a large Infected Area was scheduled under the Order. This included the whole of Wales, the counties of Monmouth, Stafford and Cheshire, the greater part of Lancashire and other smaller areas in widely separated parts of the country. No potatoes grown in an Infected Area could be moved to any place in England and Wales which was not an Infected Area, except where potatoes of approved immune varieties were accompanied by a statement that they were of an approved immune variety grown in an Infected Area not intended for planting;
(v) that all potatoes planted or sold for planting had to be officially certified either—
    (*a*) as having been grown on land free from Wart Disease, or
    (*b*) as having been inspected and found to be free from the disease, or
    (*c*) as being of an approved immune variety, true to type.

For all sales of seed potatoes it was necessary for the seller to furnish the buyer with the number of the certificate issued by the Ministry. Each certificate number was prefixed as follows :

CL (clean land) for potatoes grown in clean districts or from crops, the tubers of which had been inspected and on which no disease had been found.

TS (true stocks) for approved immune varieties which had been inspected in the field and found true to type.

The letter "A" was used in addition for potatoes grown in an infected area, and the certificates for such potatoes thus had numbers prefixed by ACL or ATS as the case might be.

It will be noted from the above interpretation of the Order (paragraph V(*c*)) that the Order provided for the continuance of the Field Inspection Scheme for immune varieties. The stocks that were inspected in the field and certified were popularly known as TS stocks. Such was the demand for these stocks that the Ministry in 1924 decided to introduce a similar voluntary scheme of field inspections for non-immune varieties. Thus, to sum up the position, by 1924, growers were able to obtain certificates relating to purity of variety for any stocks immune or otherwise, provided that such crops were found on field inspections to be of the variety specified, true to type and reasonably free from rogues. Any crops that failed to qualify for a certificate under the Field Inspection Scheme would nevertheless qualify for a clean land (CL or ACL) certificate, provided, of course, they were found to be free from Wart Disease. Moreover, crops not inspected during the growing season but which were grown on land outside the infected area, or crops grown in an infected area and found on inspection of the tubers to be free from Wart Disease, would also qualify for a Clean Land Certificate.

The Seeds Act, 1920, incorporating the Seed Potatoes Order of 1918 already referred to, made it compulsory in the case of a sale of seed potatoes for a seller to give a statement in writing of the class, variety, size and dressing, as well as the number of the relative certificate issued under the Wart Disease Order of 1918.

The operation of the Wart Disease Order and the concentration of crop inspection not only resulted in an appreciable decrease in the number of new cases of Wart Disease but also created interest amongst farmers in seed potato production, and thus the number of applications for field inspections increased from year to year. The popularity of the Field Inspection Scheme was also fostered by means of trials and research, especially in North Wales where, in 1928, a scheme for the production of high-class stocks was initiated, aided by a grant from the Ministry of Agriculture. The most important feature of this work was the study made of virus diseases and their relation to the conditions under which healthy stocks of seed potatoes could be produced. A survey of localities indicated the existence of districts where greenfly, the insect carrier of these diseases, was scarce and where the vigour and health of potato stocks had been successfully maintained over many years without the introduction of a new stock.

Associations of Growers

With the object of encouraging the production and increasing the demand for certified stocks, the growers concerned formed themselves in 1933 into a registered association. By 1935 some 70 farmers in various parts of North Wales, particularly in the coastal regions of Anglesey and the Lleyn peninsula, had joined the Association, and these produced seed potatoes which, in point of health, purity and cropping capacity, compared favourably with the best seed from any other source. The method of inspection and the standards of health and purity were mainly the concern of the staff of the School of Agriculture, Bangor, while the Executive Committee of the Association dealt with the commercial aspects of the Scheme. The standard of purity required for certification was not less than 99.5 per cent, and freedom from virus not less than 97 per cent.

The excellence of the crops produced under the Scheme was recognized by the Ministry and, in order further to encourage the production of high quality stocks and the formation of Associations, provision was made by the Seeds (Amendment) Regulations 1935, for stocks of seed potatoes grown under schemes authorized by the Ministry, to be designated Class I Special Stock. To secure authorization, all schemes had to conform to certain basic requirements, the most important of which were :

1. The scheme must be sponsored by an association of growers and be conducted in an area where the spread of virus diseases did not really take place.
2. New growers could not be admitted to the scheme except on the recommendation of the Technical Officer appointed by an Association.
3. Associations could not authorize the planting on any holding of seed from stocks in which more than 1 per cent of the plants were visibly affected with virus disease.
4. A Technical Officer had to be appointed by an Association to exercise technical supervision over the scheme.

Shortly after the conditions of the authorization of schemes were made known by the Ministry, the North Wales scheme was duly authorized, and during the years 1936 to 1943 the following schemes, operating on similar lines, were also authorized : Crymmych Seed Potato Growers' Association ; Cumberland Seed Potato Growers' Association ; Devon and Cornwall Seed Potato Growers' Association ; Durham Dales Seed Potato Growers' Association ; Northumberland Seed Potato Growers' Association ; Powysland Seed Potato Growers' Association ; Skipton and District Seed Potato Growers' Association ; Brecon and Radnor Seed Potato Growers' Association.

The strict application of the provisions of the Wart Disease Order of 1923 resulted in a substantial decrease in the number of new cases reported as the years went by, and by 1940 the losses caused by the disease had become negligible. It was therefore felt unnecessary to continue the system of scheduling large areas of the country as Infected

Areas. At the same time, the issue of clean land certificates was dropped. These changes were embodied in the Wart Disease Order of 1941. The main requirements of the Order are :

1. All outbreaks of the disease must be notified.
2. No potato tubers on which the disease has been found may be sold or offered for sale for any purpose, and no potatoes from a crop in which Wart Disease has been found may be sold or offered for sale for planting.
3. On land on which Wart Disease has occurred at any time the only potatoes which can be planted are those of approved immune varieties.
4. The Order allows the free movement in England and Wales of all Ware and Seed potatoes grown in the British Isles subject to the requirement that all potatoes planted or sold for planting must have been officially certified as having been inspected whilst growing and found to be up to the official standard of purity and health.

If potatoes are planted or sold for planting in a " protected area " they must also have been officially certified as having been grown on land free from Wart Disease. At present the only protected area is an area around the Wash from which there is a considerable export of potatoes for seed purposes.

But notwithstanding the above, general licences have been issued to meet present emergency conditions authorizing : (*a*) the planting or sale for planting in one year in the protected area of the class " Uncertified " (English once-grown) grown in that area the previous year ; (*b*) the planting or sale for planting in other parts of England and Wales until further notice of any uncertified potatoes grown in the United Kingdom.

Thus in 1941 the system of scheduling large areas of the country as Infected Areas was abolished and Clean Land (CL) certificates are no longer required, but all outbreaks must still be notified as in the past and the only potatoes which may be planted on infected land are approved immune varieties.

Field Inspections for Health and Purity

This brings to a conclusion the story of the Certification Scheme in so far as it affects the campaign against Wart Disease, but a new chapter had opened in 1940. At the outbreak of war in 1939 it was realized that if the maximum production of potato crops was to be obtained as an insurance against scarcity of supplies of other foodstuffs, further measures to maintain the health and cropping power of potato stocks should be adopted, and the Ministry therefore inaugurated a new scheme of field inspection which took into account the health of crops as well as their purity. This scheme, which was put into operation in 1940, required in the first place that, in order to qualify for inspection, growers had to satisfy the Ministry that the parent stock was of a crop certified the previous year and of a prescribed standard of health and purity, and that crops for inspection were grown a distance of 10 yards at least from other crops not eligible for entry. Secondly, that on inspection the crop was found to attain a standard of purity not less than 99.5 per cent and also reach the prescribed standard of

freedom from severe virus diseases and wildings. Two grades of certificates were issued. For the general " H " certificate the standard of freedom from severe virus diseases and wildings was set at 3 per cent. The higher grade "A" certificate was issued only in respect of crops which were grown under one of the authorized schemes for the production of seed potatoes and which attained a standard of not more than ½ per cent. of severe virus diseases and wildings.

The Scheme, except for minor details, remained unchanged until 1945, when it was decided that "A" certificates be extended to any stocks grown in areas approved as suitable for seed production, provided such stocks attain the prescribed standards of health and purity. The approved areas for these purposes are districts in the North of England with an altitude over 400 feet, and areas in Wales and the West of England with an altitude of over 500 feet and an average annual rainfall exceeding 35 inches.

It was also decided in 1945 that applications for S.S. (stock seed) certificates be accepted in respect of crops growing in the same areas which attain a standard of purity of not less than 99.95 per cent and not more than 0.25 per cent of virus diseases and wildings, including not more than four plants per acre with Leaf Roll, Severe Mosaic or wildings, and no bolters.

Since 1945, further changes in the Scheme have been brought about from time to time. Most interesting is the introduction into the Stock Seed (S.S.) requirements in 1950 of conditions designed to reduce the risk of infection by potato root eelworm. There has also been a further raising of the standard in respect of freedom from virus diseases under the Schemes for "A" and " H " certificates. The position in the present year (1951) is as follows :

1. Applications will be accepted only in respect of crops which satisfy the following conditions :

(*a*) For the " H " Certificate the parent stock must be Scotch, Northern Ireland, Eire, or Isle of Man, with " S.S.", "A" or " H " health certificate, or English or Welsh with " S.S." or "A" health certificate, issued by the relative Department or Ministry of Agriculture the previous year.

For the "A" Certificate the parent stock must have an " S.S." or "A" certificate.

For the " S.S." Certificate crops must be grown from stocks which were the subject of an " S.S." Certificate the previous year.

(*b*) Crops entered for "A" and " H " certificates must satisfy the following conditions :

(i) If crops of more than one variety are entered for certification, one vacant drill must be left between varieties.

(ii) Crops must be at least 10 yards from any other crop eligible under (*a*) above and at least 50 yards from potatoes which show evidence of substantial Virus infection.

(*c*) Applications for " S.S." certificates will not be accepted for any crops unless they are :

(i) grown on land which has not carried a potato crop in any of the previous three years ;

(ii) grown on land in which no cysts of the potato root eelworm were found on sampling and examination of the soil by an Officer of the Ministry ;

(iii) 50 yards from any other potato crop.

2. Applications in respect of less than one acre of any one variety will not be accepted—except that for crops growing in approved areas (see 4 below) the limit will be a half-acre. Applications will not be accepted for only part of any crop.

3. The following grades of certificates will be issued :

(i) *In all areas "H" certificates* for crops which besides attaining a standard of purity of not less than 99.5 per cent are found to contain not more than 2 per cent severe virus diseases and wildings and not more than 10 per cent Mild Mosaic.

These certificates will bear the letters H (E) or H (W) for *immune* varieties grown in England or Wales as the case may be and H (E) NI or H (W) NI for *non-immune* varieties grown in England or Wales as the case may be.

(ii) In *approved areas only* (see para. 4) *"A" certificates* will be issued for crops of not less than a half-acre of any one variety which attains a standard of purity of not less than 99.5 per cent and are found to contain not more than 0.5 per cent severe virus diseases and wildings and not more than 2 per cent Mild Mosaic visible under field inspection conditions.

These certificates will bear the letters A (E) or A (W) for *immune* varieties grown in England or Wales as the case may be, and A (E) NI or A (W) NI for *non-immune* varieties grown in England or Wales as the case may be.

(iii) *In approved areas only* (see para. 4) "*S.S.*" (*Stock Seed*) *certificate* for crops of not less than a half-acre of any one variety. The crops must attain an exceptionally high standard of purity and health (not more than 0.05 per cent of rogues including undesirable variations and bolters, not more than four plants per acre with Leaf Roll, Severe Mosaic or wildings, and not more than 0.25 per cent Mild Mosaic). These certificates will bear the letters SS (E) or SS (W) for *immune* varieties grown in England or Wales as the case may be and SS (E) NI or SS (W) NI for *non-immune* varieties grown in England or Wales as the case may be.

4. The areas at present provisionally approved can be roughly defined as follows :

(*a*) *For both "S.S." and "A" Certificates*

(i) The North of England (i.e., north of a line, Preston, Skipton, and Hull) at altitudes of 400 feet or over.

(ii) The South-West of England (i.e., east of a line, Truro, Newquay, and west of a line, Exeter to Minehead) at altitudes of 500 feet or over.

(iii) Wales (excepting the counties of Flint, Glamorgan, Monmouth, and parts of Denbigh and Montgomery) at altitudes of 500 feet or over.

(iv) Small portions of the counties of Salop and Hereford on the Welsh border and Monmouth on the Brecknock Border at altitudes of 500 feet or over.

(v) Anglesey, parts of the coast of Wales and the North of Devon without restrictions as to the altitude.

(*b*) *For "A" Certificates only:*

(i) In the counties of Flint, Monmouth, Glamorgan and Salop and in the Forest of Dean (Gloucester) at altitudes of 500 feet or over.

(ii) In the county of Hereford and in the Cotswolds (Gloucester) Blackdown, Brendon, Mendip and Quantock Hills (Devon and Somerset) at altitudes of 650 feet or over.

(*c*) *For "H" Certificates:*

All other areas without restrictions as to altitudes.

It should be added that the Seeds (Amendment) Regulations, 1935, which provided for Associations, were revoked in 1944, with the result that since that year Associations cannot be officially approved, and the term "Class I Special Stock" became obsolete. These

Regulations have been replaced by the Seeds (Amendment) Regulations, 1944, which provided a new classification for seed potatoes commencing with the produce of the 1944 crop.

Briefly, the particulars to be declared under the new Regulations in the case of all sales of seed potatoes in England and Wales are :

1. Name and address of seller.
2. Statement as to the class of seed potatoes, that is, whether they are :
   (*a*) Certified (Scotch) or (Northern Ireland) or (Eire) or (English) or (Welsh) or (Isle of Man).
   (*b*) Uncertified (English once grown) or (Welsh once grown) or (Scotch) or (English) or (Welsh).
3. Name of variety.
4. A statement as to the size and dressing.
5. In the case of the sale of certified potatoes, particulars regarding the certificate have to be quoted stating the reference letters and the number of the relative certificate.

" *Certified* " seed potatoes means seed potatoes obtained from crops certified under the appropriate scheme for the certification of growing crops of potatoes in each of the above-mentioned countries as the case may be.

" *Uncertified* " (English once grown) and " *Uncertified* " (Welsh once grown) mean potatoes obtained from crops grown in England or Wales, as the case may be, which crops were not certified but were grown from seed potatoes of a " Certified " class produced in the previous year.

" *Uncertified* " (Scotch) or (English) or (Welsh) mean any other potatoes obtained from crops grown in Scotland, England or Wales, as the case may be.

Thus the position at the present moment is that the Regulations governing the Potato Certification Scheme for England and Wales provide that henceforth growers on application may have their potatoes certified with a view to the issue of an " S.S.", an "A" or an " H " certificate according to the standard of health and purity attained in each case, the two former certificates being granted only in certain restricted areas, and that all sales are regulated by the Seeds (Amendment) Regulations, 1944, which are summarized above. Similar Certification Schemes are in operation in Scotland, Northern Ireland, Eire and the Isle of Man, and the several Agricultural Departments all use the same system of nomenclature for the certificates, namely, " S.S.", "A" or " H " followed by the country of origin in brackets and also in the case of non-immune varieties the letters " N.I.".

Barely 25 years ago Wart Disease seemed to be threatening the existence of one of our most important farm crops. Today it has not only been brought under control, but in the process a Certification Scheme has been developed to the great advantage of the health and purity of potato stocks in this country, and it may fairly be suggested that to this extent the disease has proved a blessing in disguise.

PLANT PARASITIC EELWORMS

E. B. Brown

National Agricultural Advisory Service, Eastern Province

It is only during the last twenty or thirty years that eelworms have become of major importance to British agriculture and horticulture. The eelworms which attack plants are minute creatures closely related to the roundworms which occur in animals. A large number of other species lead a free-living existence in the soil, where they feed mainly on decaying organic matter or other soil organisms. An important feature of many eelworms is their ability to withstand unfavourable conditions. For example, eelworms can be found adhering to the outside of onion seed ; they remain viable in a dry condition until the seed is sown, when they become active and enter the seedling onions. This article deals only with the eelworms which attack plants in this country, with particular reference to the Eastern Counties.

There are three main groups of plant parasitic eelworms which occur in Great Britain : (1) the cyst-forming eelworms (*Heterodera* sp.), (2) species of *Ditylenchus* (syn. *Anguillulina*) which includes the stem and bulb eelworm, and (3) the leaf eelworms (*Aphelenchoides* sp.). Two species which do not fall into the above groups are also mentioned.

Cyst-Forming Eelworms (Heterodera sp.)

At one time all members of the genus *Heterodera*, with the exception of *H. marioni* and *H. punctata*, were assigned to the species *H. schachtii*, although it had been known for many years that if indeed it was one species, then it existed in several specialized strains, each restricted to a well-defined host range. Morphological differences have since been discovered and most of these strains have been accorded specific rank. One species (*H. marioni*) which is a gall-former, exhibits practically no specialization to particular hosts.

The true cyst-formers have been recorded from over 170 plants from 29 families. Most of these produce lemon-shaped cysts, and cysts of this shape can be found in the majority of soils. These lemon-shaped cysts are at the present time practically indistinguishable from one another, and this is why it is not possible to sample fields specifically for the presence of beet eelworm. There are two eelworms which produce spherical cysts : potato root eelworm (*H. rostochiensis*) and bent-grass root eelworm (*H. punctata*). These can be distinguished from one another by microscopic examination.

Beet Eelworm (*Heterodera schachtii*)

Crop hosts : Sugar beet, fodder beet, mangold, red beet, spinach, cabbage, kale, cauliflower, broccoli, Brussels sprouts, turnip, swede, mustard, cress, radish, kohlrabi, rape and all related crops.

Weed hosts : Cysts have been found on a number of weeds growing in fields infested with beet eelworm. Those in the families *Chenopodiaceae* and *Cruciferae* are almost certainly authentic hosts of this eelworm, but the position of some weeds in other families is uncertain. Some of the more important weed hosts in these two families are as follows :

Chenopodiaceae: fat-hen (white goosefoot) (*Chenopodium album*), sowbane (*C. hybridum*), common orache (*Atriplex hastata*).

Cruciferae: charlock (*Sinapis arvensis*), hedge mustard (*Sisymbrium officinale*), shepherd's purse (*Capsella bursa-pastoris*), wild radish (*Raphanus raphanistrum*), treacle mustard (*Erysimum cheiranthoides*).

Chickweed (*Stellaria media*), docks (*Rumex crispus* and *R. obtusifolius*) and redshank (*Polygonum Persicaria*) are also authentic hosts of this species.

This eelworm is a serious pest of sugar beet and mangolds on the Continent and in America. Although it is established in the black fen area of this country, it is not yet widespread, and the Sugar Beet Eelworm Order, 1943, was introduced to limit the growing of susceptible crops on fields known to be infested. The growth of the *Brassica* host plants is apparently not affected.

Potato Root Eelworm (*Heterodera rostochiensis*)

Host plants : Potato, tomato and bittersweet (*Solanum Dulcamara*).

This eelworm causes severe losses to potatoes in the main potato-growing areas. Tomatoes are also attacked, both under glass and out of doors. Bittersweet is a hedgerow plant and does not normally occur in fields liable to be infested with potato root eelworm.

Pea Root Eelworm (*Heterodera göttingiana*)

Host plants : Peas, field beans and vetches (i.e., *Vicia* and *Pisum* sp.).

This species occurs spasmodically in the Eastern Counties, where it sometimes causes the failure of pea crops on fields which have not apparently grown a susceptible crop for several years. In this respect it appears to differ from other cyst-forming eelworms, which normally only cause the failure of a crop when that crop is grown too frequently on the same land. In other parts of the country, however, pea sickness does appear to be related to overcropping with peas.

Cabbage Root Eelworm (*Heterodera cruciferae*)

Host plants : *Cruciferae* only (especially *Brassicae*). This eelworm is frequently recorded but probably often passes unnoticed. No cases of severe damage have yet been recorded, although large numbers of cysts can be found on the roots.

Cereal Root Eelworm (*Heterodera major*)

Host plants : Cereals, chiefly oats, and some grasses (*Lolium perenne*, *Bromus* sp., *Avena fatua*), This species is well known as a pest of oats in some parts of the country. In the Eastern Counties it has not

previously been of any importance although small numbers of cysts could often be found on the roots of cereals. Nevertheless, during 1951 several cases of severe damage to oats occurred.

Carrot Root Eelworm (*Heterodera carotae*)

Host plants : Carrot and wild carrot only. Carrot root eelworm is a recently described species and is known only in the Chatteris area (Isle of Ely) where it caused the failure of a field crop in 1950.

Clover Root Eelworm (*Heterodera schachtii* var. *trifolii*)

Host plants : Clovers (*Trifolium pratense*, *T. repens*), docks (*Rumex* sp.), cultivated mustard (*Brassica alba*), shepherd's purse (*Capsella bursa-pastoris*), woad (*Isatis tinctoria*), hemp-nettle (*Galeopsis* sp.) chickweed (*Stellaria media*), and ribwort (*Plantago lanceolata*)*.

The larvae can also enter sugar beet but probably do not breed successfully. This eelworm is widespread and is almost certainly indigenous. It is probably unspecialized, capable of attacking a wide range of hosts. No instances of damage to clover have been recorded.

Bent-Grass Root Eelworm (*Heterodera punctata*)

This species is known in this country only on *Agrostis stolonifera* but has been recorded on wheat in Canada. The cyst of this species is spherical in shape and occurs commonly in old pastures. Prominence has recently been given to this species owing to its regular occurrence in potting soils and the refusal of the American authorities to admit plants which have been grown in infested soil.

Hop Root Eelworm (*Heterodera humuli*)

Host plants : Hop and nettles. Hops do not appear to suffer to any great extent from attacks by this species.

Root Knot Eelworm (*Heterodera marioni*)

This species has a very wide host range and as far as is known is almost confined to glasshouses in this country, where it is well known as a pest of tomatoes, cucumbers and lettuce. *Narcissus* is not a host of this eelworm. The cystic females remain inside the galls produced on the roots.

Species of *Ditylenchus* (syn. *Anguillulina*)

Stem and Bulb Eelworm (*Ditylenchus* (*Anguillulina*) *dipsaci*)

This species has been recorded from well over 200 species of plants. It exists in specialized strains capable of attacking a single or few species of plants and also in unspecialized strains attacking wider host ranges. Strains are not able habitually to transfer from species to species of

*This is a previously unpublished record. Cysts indistinguishable from clover root eelworm were found on the roots of *P. lanceolata* plants grown in pots in infested soil from Chirk, Denbighshire (1945).

host at random, but it is not yet known whether even a highly-specialized strain may not become less specialized over a period of time and capable of adaptation to other hosts. The behaviour of a particular strain possibly depends to some extent on the ancestral cropping history to which that strain has been subjected. The information given below is no doubt far from complete but it sets out the position as it is known at the moment.

The eelworm does not occur in root tissue but is confined to stem, bulb and leaf tissue, where it is endoparasitic (feeding internally). Plants exhibiting swellings, distortions, lesions or decay should be suspect.

Eelworms of this species can often be found on the seeds of attacked plants (e.g., onions, red clover and teazel). When such seed is sown the eelworms become active and enter the germinating seedlings. It is difficult to be certain how important this seed-borne infestation is, but it can result in the introduction of the pest to a previously uninfested field and there is strong presumptive evidence that attacks due to seed transmission do occur.

Fuller's Teazel strain. The eelworm was first described from teazel (*Dipsacus fulloum*) in Germany. Attacks on this plant have appeared in Somerset where the disease is known as "cabbagy" plant and an attack has been confirmed at Brandon (Suffolk) in 1950. Little is known about the host range of this eelworm.

Oat-onion strain. The crops attacked and the conditions caused are: Oats (tulip root or segging), onions (bloat), field beans (stunting), rhubarb (crown rot, possibly associated with *Bacterium rhaponticum*), parsnips (canker, but this may also be caused by other means), mangolds and sugar beet (canker, but uncommon), strawberry (shortening of stalks and leaf puckering).

Weed hosts: Cleavers (*Galium aparine*), chickweed (*Stellaria media*), mouse-ear chickweed (*Cerastium vulgatum*), scarlet pimpernel (*Anagallis arvensis*), black bindweed (*Polygonum Convolvulus*), sandwort (*Arenaria serpyllifolia*), meadow grass (*Poa annua*), annual nettle (*Urtica urens*), and red deadnettle (*Lamium purpureum*).

No spring varieties of oats are resistant to this eelworm. Of the winter varieties Grey Winter, Unique, S.81 and Picton were considered to be fairly resistant but the resistance of Picton seems to have broken down recently. Attacks on the variety S.147 are frequent and it appears to be a particularly susceptible variety.

Clover strain. Host plants are: Red clover (*Trifolium pratense*) and kidney vetch (*Anthyllis vulneraria*).

The main symptoms on red clover are a stunting of the plant and thickening of the leaf stems. This often results in the plant forming a rosette on the ground and death may later ensue. Affected plants often occur in patches in the crop. Alsike clover is less susceptible and lucerne, trefoil and sainfoin are resistant.

The following weeds growing in patches of severely affected clover were found to be attacked: *Rumex crispus*, *Ranunculus acris*, *Stellaria media*, *Cerastium vulgatum*, *Geranium molle* and *Lamium purpureum*.

Narcissus strain. Host plants: *Narcissus* sp., bluebell (*Scilla nonscripta*), snowdrop (*Galanthus nivalis*), *Sprekelia formosissima*, *Hymenocallis calathina*, *Scilla campanulata*, *Primula* sp.

This strain is the common bulb eelworm of *Narcissus*. The foliage of attacked narcissus plants is abnormally yellow and distorted, exhibiting small swellings known as "spickels". The flower stem may also be crippled and the flower itself fail to open. The eelworms also breed rapidly within the bulb, producing brown ring symptoms and later causing the death of the bulb.

Tulip strain. Attacks on tulips at the moment occur most frequently in Holland (Lincs). The eelworm produces varying degrees of distortion to leaves, stalks and flowers. There is some evidence that *Narcissus* is also a host of this strain.

Phlox strain. This strain has a fairly large host range mainly in the genera *Phlox*, *Oenothera*, *Gilia*, *Collomia*, *Dianthus*, *Schizanthus* and *Solidago*. Attacks on *Phlox* are well known and widespread. The leaves become narrow and distorted; the shoots sometimes appear spindly and soft, or may be badly stunted; cracks appear in the stems, and occasionally there is a great increase in the number of basal buds.

Hyacinth strain. Attacks on hyacinth are rare in this country at the moment. There is a recent record from Spalding (Lincs). The leaves are short and twisted and the leaf bases are swollen. The flower spikes are stunted and have malformed heads. The symptoms within the bulb are similar to those of attacked *Narcissus* bulbs.

Lucerne strain. The lucerne race is well known overseas, and is now making an appearance in this country. There have been two records from Essex recently. The symptoms of attack on lucerne are similar to those on clover. The plants are stunted and the leaf stems are greatly thickened.

Wild White Clover strain. This strain has been recorded from Kent, Holland (Lincs) and Cambridge. The main symptom is a swelling just below the flower-head, and swellings also occur on the leaf stalks.

Potato Tuber Eelworm (*Ditylenchus destructor*)*
Crop hosts: Potato, Iris.

Weed hosts: Corn mint (*Mentha arvensis*) and creeping sowthistle (*Sonchus arvensis*).

This eelworm causes severe losses to potatoes in parts of the fens. It attacks the tubers causing a rot which somewhat resembles that

*Evidence has recently become available that this species has a much wider host range.

caused by blight, the plant itself appearing perfectly healthy. The cracking of the skin is a characteristic symptom of attack on the tuber.

Leaf Eelworms (*Aphelenchoides* sp.)

Chrysanthemum Eelworm (*Aphelenchoides ritzema-bosi*)

Host plants: *Chrysanthemum* sp. (including *Pyrethrum*), *Aster*, *Calceolaria*, *Callistephus*, *Dahlia*, *Delphinium*, *Doronicum*, *Gaillardia*, *Gloxinia*, *Ocymum*, *Pentstemon*, *Phlox*, *Rudbeckia*, *Valeriana*, *Verbena*, *Zinnia* and Strawberry.

Weed hosts: Creeping buttercup (Ranunculus repens) and Groundsel (*Senecio vulgaris*).

This species is an endoparasite of all the above plants with the exception of strawberry. It may cause a leaf blotch on these plants similar to the well-known damage to chrysanthemum leaves. On the strawberry it is ectoparasitic (feeding externally) and the presence of the whitish feeding areas at the base of the mid-vein is a fair indication that the plant is infested.

Black Currant Eelworm (*Aphelenchoides ribes*)

This eelworm appears to be almost confined to the varieties Westwick Choice and Daniel's September. It is considered by the American workers to be the same species as the previous one. It leads an ectoparasitic existence within the buds causing these to die and leave bare patches of stem.

Leaf Blotch Eelworm (*Aphelenchoides fragariae* (syn. *A. olesistus*))

This eelworm has been recorded from a large number of hosts, the best known probably being begonias, ferns, violet and, more recently, strawberry. There has recently been a case of damage to scabious (*Scabiosa caucasica*) in Suffolk. It is an ectoparasite of strawberries and violets but lives inside the leaves of begonias and ferns causing a leaf blotch.

Narcissus Bulb and Leaf Eelworm (*Aphelenchoides subtenuis*)

Narcissus is the only host of this species and attacks on the varieties Sir Watkin, Henry Irving, Christmas Glory, Emperor, Soleil D'Or and Helios have been recorded. It appears to be restricted to the south-west of the country especially the Isles of Scilly. The damage resembles in some respects that caused by the bulb eelworm in *Narcissus*.

" Strawberry Eelworm "

Until recently this was regarded as a separate species occurring only on strawberries. It is now known that this plant is attacked both by *Aphelenchoides ritzema-bosi* and by *A. fragariae* (*A. olesistus*) the two species apparently producing identical symptoms. (See above.) Strawberry is also attacked by *Ditylenchus dipsaci*.

Other Species

Ear Cockles (*Anguina tritici*)

During the years 1914 to 1918 there was a considerable increase of this species owing to the use of undressed home-saved seed. It is not now often recorded although it may be overlooked. It causes galls (ear cockles) instead of grain in the ears of wheat and, to a less extent, rye.

Root Lesion Eelworm (*Pratylenchus pratensis*)

This species is a very common inhabitant of pasture soils. It is well known as a pest of many crops overseas (tea, coffee, cotton, etc.) and may be of more importance in this country than is generally recognized. It appears to exhibit no preference for any particular host, but to be a general root feeder, associated with root rots. In this country it is known as a pest of *Delphinium* and has been recorded on several other plants.

ABSTRACTS

ANIMAL NUTRITION

The Nutrition of the Pig

The Importance of Proper Housing

Experience has accumulated on the importance of providing correct housing for pigs if rearing losses are to be minimized and economy attained in fattening. Shanks[1] has described a dry, warm house, free from the smell of excreta, in which the temperature during one year ranged only from a minimum of 62°F. to a maximum of 85°F., the greatest variation in any 24 hours being 12°F. The air-space per pig was 50 cu. ft. and the floor-space 6⅔ sq. ft. Adoption of this type of house practically eliminated pneumonia, savaging, fighting and tail-biting. Howie et al.[2] consider that the main cause of ill-health in young pigs is cold, damp, and draughty housing, and they have found that wooden arks give satisfactory results in rearing. The effect of temperature has also been studied by Heitman and Hughes[3]. These workers found that a temperature of 75°F. was best for pigs between 70 and 140 lb., the average daily gain being greatest and the food per 1 lb. gain being least; for pigs of 160 to 260 lb. the best results were obtained between 60° and 65°F.

Protein Requirements

It is generally agreed that efficient rearing and fattening can be obtained on rations containing considerably less protein than used to be thought necessary. Woodman and Evans[4] have shown that

satisfactory results can be obtained by feeding a ration containing only 7 per cent fish meal from weaning up to 90-100 lb. live weight and no high protein food at all thereafter ; a mineral supplement was given to compensate for the lack of fish meal. A recent article by Duckworth and Head[5] contains useful practical suggestions. A large number of cereal mixes are listed, any one of which can be fortified by one of a number of protein-mineral mixes, and fed in prescribed quantities for weaners, fatteners, pregnant sows, nursing sows, etc. A timely reminder of the possible variability of cereals in protein content is provided by McElroy et al.[6]. These workers used oats ranging from 9.5 to 16.3 per cent crude protein, and barley from 9.4 to 17.1 per cent. A mixture of oats and barley, containing 16.6 per cent protein, gave better results than any of the lower protein mixtures of the two cereals. The conclusions drawn from further experiments, in which the cereal mixtures were supplemented with animal protein, unfortunately appear to be vitiated by errors in calculating the overall percentages of these further rations.

Supplementary Feeding

Much attention is being given to methods of saving imported concentrates by using grass, potatoes, fodder beet, and swill. Braude[7] has discussed these in general and has drawn attention to points which have to be observed for success. Although pigs have been fattened on swill alone[8], it is usual to feed a fixed amount of meal and then offer the supplement to appetite.

The use of fodder beet has been described by Dunkin and Cooper[9] and by Braude and Mitchell[10], the former workers using Hunsballe and the latter comparing White Otofte with mangolds. Dunkin and Cooper state that the fodder beet should be introduced by gradual replacement of meal in the ration of pigs which have reached 100 lb. live weight and should be discontinued at 210 lb. Meal was restricted to 3 lb. per day and beet was finally being consumed at the rate of 20 lb. per day. Braude and Mitchell found that mangolds were too bulky (too low in dry matter) for the pigs to eat enough for the attainment of a satisfactory growth-rate, but that fodder-beet was a success. Both sets of workers found that it was necessary to employ a meal somewhat higher in protein than was required for an all-meal ration ; but, even so, the use of fodder beet was more economic.

Potatoes, steamed and ensiled, have been used similarly. Robinson[11] reports the introduction of these to pigs of 80 lb. weight, 2 lb. of meal being also given ; in the later stages, up to 20 lb. potatoes were being eaten daily. A comparison of cooked and raw potatoes has been made by Braude and Mitchell[12]. They found that whereas 4.7 lb. of cooked potatoes could replace 1 lb. of meal, the same result required 7 lb. of raw potatoes. It might not be out of place to remark that, whereas potatoes have only about one-quarter more dry matter than the *best* varieties of fodder-beet, the yields of the two crops are such that beets may supply over twice as much dry matter per acre as potatoes.

It is necessary, however, to emphasize that the dry matter percentage varies considerably with different varieties of beet, and care should be exercised in making a choice.

Grass meal is commonly present in small proportions in concentrate mixtures but Woodman and Evans[13] have shown that it can be included usefully in considerably greater quantities than is usual. They found it possible to use up to 33 per cent of a grass meal in the ration for pigs between 50 and 150 lb., but that it had to be reduced to 20-25 per cent thereafter. It was comparable to fine bran in feeding value. However, this meal had only two-thirds of the usual amount of fibre and it would not normally be possible to feed dried grass in such large proportions.

General

Among articles of a general nature which have appeared recently there may be mentioned those by Worden[14] and by Bostock[15]. The former also provides an extensive bibliography of some eighty references.

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S.M.B.

After this article had been prepared, a paper by J. R. McLagan and H. Nasr of the Rowett Institute was noted (*Scot. J. Agric.*, 1951, **30,** 143). These workers found that the cost of fattening on raw and on boiled potatoes was very similar. If anything, it was in favour of the boiled potatoes and the pigs fattened more quickly on these, requiring 4-5 weeks less.

POULTRY HUSBANDRY

Nutrition

Studies on the animal protein factor continue to be frequent amongst papers on poultry nutrition. The initial enthusiasm that invested the earlier contributions has now died down and a more cautious note prevails amongst recent papers. A paper by Almquist and Merritt on the " Effects of Vitamin B_{12} and Crystalline Aureomycin on Growth of Poults " (*Poult. Sci.*, 1951, **30,** 312) is a good illustration of this more recent attitude. The authors demonstrate that very little increased growth by turkey poults followed the addition of crystalline B_{12} to an all vegetable diet, but aureomycin resulted in a substantial improvement. A combination of the two substances did not lead to any improvement over that found with aureomycin alone. The conclusions reached by the authors are that birds may carry a sufficient reserve of B_{12}; other work suggests that this reserve may be sufficient for a considerable period. Atkinson and Crouch dealing with a similar subject, namely, " The Effect of Feeding an A.P.F. Concentrate and Fish Solubles on the Growth of Broadbreasted Bronze Turkeys " in *Poult. Sci.*, 1951, **30,** 81-5, held similar views on the need of poults for B_{12} supplements when fed a diet containing an A.P.F. concentrate as such or in the form of fish solubles. These authors considered that turkey poults receiving an A.P.F. supplement or fish solubles did not show any improvement when given additions of B_{12}. The data presented give some colour to the opinion that is increasingly held in some quarters, i.e., that factors other than B_{12} in the A.P.F. group are of greater importance than has hitherto been thought. In the same Journal (*ibid.*, 1951, **30,** 11-7) Peeler, Miller, Carlson, Norris and Heuser make much the same conclusions in their paper on " Studies of the Effect of Vitamin B_{12} on Hatchability ". Although they refer to the improvement in hatchability achieved by additions of B_{12} to birds fed on an all vegetable diet, they draw attention to the relatively low hatchability achieved when hens kept in cages on a diet depleted of A.P.F. received weekly injections of B_{12}.

If one may attempt to formulate conclusions at this stage, it appears that B_{12} supplements are mainly of value to the practical farmer in cases where the diet is lacking in animal protein and when the birds are kept on wire or in any fashion where they are away from their droppings and the ground. On the other hand, additions of the other factors in the A.P.F. group may be of value where birds are kept on normal diets and under less artificial conditions. Biely, March, Stevens and Casorso in discussing "A.P.F. Supplements in the Chick Ration " in *Poult. Sci.*, 1951, **30,** 143-7, indicate the variable results achieved by additions of B_{12}, but refer to the substantial increase attained by the addition of an antibiotic in rations with and without fishmeal. It has been suggested that the antibiotic stimulates the production of at least one of the factors of the A.P.F. group other than B_{12}.

On another aspect of nutrition, Nikolaiczuk in an article entitled " Some Observations upon the Feeding Value of Millet for Chicks " in *Quebec Agriculture*, 1950, **7,** 160-3, demonstrates that millet has a

feeding value equal to barley but inferior to mixed cereals. Nikolaiczuk considers that the presence of millet improves the texture of a mash and that high levels do not predispose to inferior feathering and " pasting " of the beak which does sometimes occur with high level barley rations.

Writing in the *Journal of Agricultural Science*, 1950, **40,** 44-9, K. J. Carpenter and J. Duckworth make some interesting comments on the effect of certain methods of preparing fish meal. In their paper on " The Nutritive Value of Herring 'Alkali-Reduction ' Meal for Chicks " they discuss the value of the fish meal supplied by this process—a process primarily designed for the recovery of herring oil. From their experimental work it is concluded that the process results in a meal which is toxic at high levels of feeding and in which the B_{12} and cystine are destroyed. Additions of both B_{12} and cystine, while improving the value of the meal, gave results under trial which indicated that the value of the protein content had deteriorated. These findings would suggest that greater consideration should be given to the methods of preparing fish meals and that although total protein levels may be the same, the nutritive value of meals may differ widely. It may also be concluded that some form of guarantee for the B_{12} content in both fish meals and fish solubles would be of value to the poultry keeper.

In the same Journal (*ibid.*, 1950, **40,** 39-43), J. Duckworth, J. M. Naftalin and A. C. Dalgarno report on " The Digestibility of Linseed Oil and Mutton Fat by Chicks ". Some of their conclusions are of interest to poultry keepers because of the increased production and use of linseed. The authors investigated the possibility that the chick with a body temperature above that of most farm animals might have some advantage in digesting high melting point fats. No advantage was experienced, but it appeared that with linseed oil early feeding increased the birds' capacity to digest greater quantities. This was not the case with mutton fat.

Management

Stewart and Upp (*Poult. Sci.*, 1951, **30,** 63-6), discuss " The Effect of Form of Feed on Growth and Feed Efficiency, Pellets *versus* Mash *versus* Granules for Broilers ". The authors maintain that the several methods of feeding did not lead to differences in food efficiency or rate of growth. There was a slightly greater tendency towards cannibalism with the batches fed pellets or granules. A rather different conclusion is arrived at by Heuser and Scott in the case of duckling. These authors in a paper entitled " Studies in Duck Nutrition I " (*ibid.*, 1951, **30,** 161-3) found that pellet feeding with duckling resulted in superior growth compared with both dry and wet mashes.

A further commentary on the built-up litter system is given by Kennard and Chamberlin in a revised issue of *Mimeograph Series* 6, 1950, published by the Ohio Agricultural Experiment Station entitled " Give Built-up Litter a Chance to Function ". Amongst the authors' statements

particular stress is laid on the need to control moisture by stirring. It is also held that the benefits from the system cannot be obtained if the litter is too shallow or too dry. Dampness appears to be more frequent in this country than in U.S.A. and the authors suggest that additions of litter greater than are commonly used in this country are desirable.

Breeding

Egg weight is the subject of a paper by Lerner in *California Agriculture*, 1950, **4**, 6, in an article on " Improved Egg Size " and by the same author and Cruden in *Poult. Sci.*, 1951, **30**, 34-41, in a paper on " The Heritability of Egg Weight ; the advantages of Mass Selection and of Early Measurements ". In both papers it is emphasized that egg weight is highly heritable—60 per cent compared with 5 per cent for egg numbers—and therefore egg size can be influenced rapidly by individual selection. In both papers the authors point out that it is unnecessary to weigh eggs continually throughout the laying season. Lerner considers that the average weight of eggs produced in the course of five days in November provides an adequate estimate of the genetic value of a bird for egg size. The joint authors also consider that the size of the pullet appears to exert no positive effect on egg weight.

R.C.

CROPS AND PLANT BREEDING

Blight-resistant Potatoes

Black (*Proc. roy. Soc. Edinb.*, 1949, **63**, 290-301 and 1950, **64**, 216-28), reports on the inheritance of *Phytophthora* resistance derived from *Solanum demissum*. The transference of this resistance to *S. tuberosum* is the aim of practically all programmes for the production of blight-resistant potatoes. In Great Britain three strains of *Phytophthora infestans* are recognized. Strain *A* is the common strain ; *B* and *C* are found only when varieties or seedlings resistant to *A* are grown. The leaves of a potato variety or seedling may be susceptible to strains *A*, *B* and *C*, or to *B* only or to *C* only, or to none. Black finds that there is a fairly simple Mendelian scheme to describe the transmission of resistance. The factor Rb is associated with resistance to *A* and *B*, Rc with resistance to *A* and *C*. Resistance to *A*, *B* and *C* is associated either with the presence of Rb and Rc or of another factor Rbc. In back-crosses of *demissum* × *tuberosum* hybrids to *S. tuberosum* there is found a deficiency of resistant seedlings, but satisfactory Mendelian ratios are usually obtained in intercrosses between hybrid derivatives.

A useful review by Rudorf (*Amer. Potato J.*, 1950, **27**, 332-9) of German work on this problem shows how multiplicity of strains of the pathogen complicates the breeders' task. In Germany eight strains of *P. infestans* are recognized. Out of 135,000 F_2 seedlings from the cross (*S. demissum utile* × *S. tuberosum*) × *S. tuberosum*, only 85 were left after twofold infection with the eight races. During the period 1940 to 1944 about 500,000 seedlings were produced yearly. In 1941

40,000 resistant seedlings were under observation. By 1942 these had been reduced to 2,000 clones, and by 1944 only 200 were retained as promising. About half of these were discarded as wart susceptible and there was further elimination because of virus susceptibility.

The resistant varieties so far released in Germany are late maturing, and attention is now being paid to the selection of resistant early varieties from crosses with Frühmolle, Erstling (= Duke of York), Vera and Frühbote. Other American species are being introduced into the breeding programme for the sake of their resistance to other adverse factors, especially viruses and Colorado beetle.

Reddick and Petersen (*Amer. Potato J.*, 1950, **27,** 1-10), describe some blight-resistant new varieties in the U.S.A. They are not resistant to all races of blight and some have other defects, too. One of them, Essex, is being grown fairly widely.

J.L.F.

CROP HUSBANDRY

The Ley in Farming Systems

A restatement of the place of the ley in farming systems is made by Prof. T. L. Bywater (*J. Brit. Grassland Soc.*, 1951, **6,** 1-9), who is convinced that the advantages of a ley can be secured to the full only in a system of alternate husbandry. He considers the controversial question as to whether the alternate system of husbandry, on much the same pattern that has been applied so successfully in the mixed farming areas of Scotland, can and might replace the system of land use based on permanent arable and permanent grass in the mixed farming areas of England and Wales. It would seem at first (from statements made by grassland enthusiasts), he says, that there is everything to be said for an all-grass farm ; however, there are at least two reasons for alternating grass with arable crops. Firstly, unless leys are very well managed, their output deteriorates, particularly if they are cut for conserving for winter, as they must be to some extent on all dairy farms ; secondly, as we improve the productivity of our leys, we increase the number of cattle and sheep that can be kept per unit of land. In order to avoid disease, as well as to provide much needed direct human food crops, leys should be alternated with arable crops for 3 or 4 years.

Output

On the question of food crops, Sir William Gavin makes some interesting comments in an article " The Way to Higher Crop Yields " (*Agriculture*, 1951, **58,** 105-11). He refers to better seeds and the development of new herbicides and fungicides, but the article is chiefly useful because of the survey it provides of the use of fertilizers in this country. He thinks that more nitrogen, wisely used, is one of the most

important means of achieving higher production, though overriding all other factors is the basic problem of converting the pioneer skill and knowledge of the few into the practice of the many—that is to say, into normal farming routine. But farming progress and higher crop yields depend upon the following conditions, all of which are outside the governance of farmers. They are: remunerative farm prices, security against sudden collapse of markets, and organizations for the spread of knowledge.

Two aids which will be found useful by those who have to plan the cropping of farms have been published recently. One is a slim bulletin of only eight pages called " Cropping for the Feeding of Livestock for Milk Production "; it is obtainable from the Welsh Headquarters of the N.A.A.S., and it contains the essential information which is needed when designing a series of crops for dairy cows in a mainly livestock area in a region of high rainfall.

The other is a book by Dr. T. W. Evans entitled *Land Potential* in which is set out a formula for measuring farm production, so that high farming shall go hand-in-hand with a fertility build-up which is slightly in excess of extractive output.

Selective Weed-Killers

A tremendous amount of information about selective weed-killers is being published. A number of recent papers on these and allied chemicals has been gathered together into the new journal called *Search*, which is confined to publications written by the staff of Plant Protection Ltd. Included in the first issue are " Pre-emergence Weed Killer Possibilities " and " Chemical Weed Control in Grassland " by Dr. E. Holmes. (The same writer contributes some remarks on " Insecticide-Fungicide Seed Dressings " to the second number of *Search*.)

In the January, 1951, *Crops and Soils*, published by the American Society of Agronomy, reference is made to our lack of knowledge of how to grow weeds as opposed to destroying them; this has led to difficulties in the cultivation of weeds for experimental purposes. The need for developing resistant crop varieties that can be selectively weeded with chemicals is mentioned, and the suggestion is made that research on weeds has suffered from premature publication of results founded on inadequate data. Reference is made to new products used in controlling weeds in ditches and dykes.

D.H.R.

Molybdenum Deficiency

During the last few years research has been progressing in various research institutes of the world on the part played by the micro-nutrient, molybdenum, in plant growth. Whilst the element is doubtlessly required by all economic crops, those most susceptible to the deficiency which affect the horticulturist are lettuce and the brassica family, particularly cauliflower and broccoli. As molybdenum has also an important connection with legumes, it must be realized that one is dealing either with the effect of the element on the symbiotic nodule organism, rhizobium, or the effect on the plant itself. Experimental work has shown that molybdenum is utilized by both, but in the field the responses to application of molybdenum to clovers have been to activate rhizobium which, in turn, supplies the host plant with nitrogen. The two following papers deal with theoretical and practical aspects of molybdenum nutrition.

Molybdenum nutrition of crop plants. STOUT, P. R., MEAGHAN, W. R., PEARSON, G. A., and JOHNSON, C. M. *Plant and Soil*, 1951, **3,** 51-88.

Using tomato and garden peas, numerous experiments are described and the following points discussed.

Additions to soils of up to one pound of sodium molybdate per acre is reflected by a large uptake by the plant. Increasing the phosphate levels at the same time pushes up the molybdenum intake as much as tenfold.

Absorption experiments with radioactive molybdenum showed that molybdates can be absorbed from very low concentrates (one part per million) of culture solution. They also show that molybdate is absorbed more readily from acid than neutral solutions. In view of the fact that soil molybdate is less soluble under acid soil conditions, this finding is most important. The authors point out that, as liming releases molybdates, the amount made available for plant uptake is greater than the loss incurred by the decreasing absorption of the plant roots in the alkaline media.

In order to suppress the uptake of molybdates, the procedure consisted of lowering soluble phosphate and increasing sulphate levels by the addition of gypsum. Applications of 3,920 lb. of gypsum per acre reduced the molybdenum content of peas from 16.0 to 2.75 p.p.m.

The Control of " Whiptail " in Broccoli and Cauliflower. PLANT, W. *J. Hort. Sci.*, 1951, **26,** 109-17.

Field experiments are described involving molybdenum deficiency (whiptail) in broccoli and cauliflower. Visual symptoms, which are described in detail, show a wide variation in type. There are six illustrations which show different aspects of whiptail in field specimens. All the varieties observed during these trials (1947-50) appeared to be susceptible to the deficiency.

The deficiency was found on a wide range of acid soils including granite, Devonian (shale), Old Red sandstone, Keuper and Lower Greensand. It appeared that the type of soil had little effect on the incidence of the deficiency, but all affected soils were acid. Whiptail, however, does not occur on every acid soil.

Whiptail plants contained 0.02 to 0.08 p.p.m. molybdenum, whereas healthy plants contained 0.12 to 6.00 p.p.m. molybdenum. The deficiency was prevented by the use of ammonium and sodium molybdate at 2 to 4 lb. per acre, and by ground limestone at rates which raised the soil *p*H to neutrality. Both molybdates and lime raised the molybdenum content of the plants.

In two experiments with broccoli, gypsum lowered the molybdenum content of the plants. In one case where the molybdenum value of the leaves from the gypsum treatment fell to 0.05 p.p.m., the incidence of whiptail increased compared with the control. Whiptail plants contained considerable amounts of manganese, but in the experiments reported there was no evidence of manganese toxicity.

Whilst admitting the usefulness of molybdates in correcting whiptail, it is recommended that liming should first be carried out, since the effect of such treatment is to increase the availability of molybdenum in the soil. Where liming fails to correct the deficiency, or the deficiency is found to occur on neutral soils, then dressings of molybdate at 2 to 4 lb per acre should be given.

W.P.

FRUIT

Fruit Culture in Kansas

The climate of Kansas, U.S.A., suffers from extremes, with cold winters, late spring frosts and hot dry summers. The chief tree fruit grown is the apple, with sour cherries occupying second place. The apple, therefore, occupies almost the whole of *Kansas Agricultural Experiment Station Bulletin* 337, entitled " Growing an Orchard in Kansas ", by R. J. Barnett.

Much of the information given is similar to that contained in official bulletins in this country. Some is obviously valid only under Kansas conditions, but certain points appear to be novel or valuable in providing a basis of comparison with practices in Great Britain.

Windbreaks on the west and south of the orchard are considered worthwhile if started early and composed of suitable trees. These include *Pinus ponderosa*, *P. austriaca*, *Biota orientalis* (Chinese Arbor-vitae), *Tamarix* sp. (Tamarisk) and *Celtis occidentalis* (Hackberry). A warning is issued against those species of trees that sap the moisture from a wide area, such as *Populus* sp. (Cottonwood), *Ulmus* sp. (Elm), *Juglans nigra* (Black Walnut), *Maclura pomifera* (Osage Orange), and *Juniperus virginiana* (Red Cedar). Certain of these are also condemned because they may harbour pests or diseases that affect fruit trees.

Spring frost damage should be avoided by choosing a site with good air drainage ; heating and smudging have not proved profitable methods.

The sour cherries grown in Kansas (Early Richmond, Montmorency and English Morello) are said to resist frost damage to blossoms more than the apples, which in turn are more resistant than pears or peaches.

The first profitable crop of apples, from trees on vigorous rootstocks, is expected at from six to eight years of age. Before the war land cost from 60 dollars to 150 dollars an acre, and it was estimated then that each acre of really good orchard represented an additional investment of 200 dollars or more by the time it reached profitable bearing age. More recent figures are not available.

The grower is advised to go slow with new varieties, and is given a useful score card that can be used in assessing the value of any new variety he may test out on a small scale. In this 50 points are allocated to the tree (20 to productivity, 13 to pest resistance, 10 to strength and vigour, and 7 to precocity) and 50 to the fruit (15 to colour, 10 to size, 10 to quality and 15 to handling value).

Nowadays not more than five varieties of apple should be planted in an orchard, which may be up to 30 acres in extent. To ensure good cross pollination, it is recommended that blocks of one variety should not be more than six rows wide, preferably only four rows, and each block should alternate with two or more rows of a pollinator variety.

It is usual to plant strong maidens four to five feet high, but winter-hardy rootstocks, e.g., Hibernal and Virginia Crab, are often planted as stems in the orchard and worked by budding on the branches after one year's growth. Dwarf trees on M.VII and M.IX and on quince are used only for gardens.

The wide spacing of permanent trees is advised and fillers are considered a doubtful proposition. They should be used only by those growers who are sure they will remove them before they crowd the permanent trees, usually about the tenth year in the apple orchard.

Protection from rodents, mice and rabbits, is achieved by surrounding the trunks with a guard of ¼-inch mesh " wire cloth ", which is a sort of wire netting with a square mesh. This is considered to be more efficient and cheaper in the long run than wood veneers or stiff paper protectors.

An experiment at the station orchard at Manhattan with young apple trees under clean cultivation failed to show profitable results from applications of nitrates, phosphates, or potash on a soil deficient in phosphorus for grain crops ; these fertilizers should be used only in bearing orchards. In young orchards a system of annual cover crops with three months clean cultivation in the summer is recommended, the crops being chosen for winter hardiness and ability to fix nitrogen. The best mixture for yield and apparent value is rye and winter vetch. It is suggested that a four-foot strip down the middle of each row might be left to develop seed and thus assist in reseeding the area the following autumn. This practice has shown no detriment to the young trees.

In established orchards grass and clover swards in strips or a complete cover may be useful to resist soil erosion but little is yet known

about the best management for these swards. In drought areas straw mulching is recommended. Sufficient straw is applied each year to maintain a layer four inches thick after it has settled. The risks of mice and fire are noted.

Intercropping is not favoured, but if it is done, a strip at least eight feet wide should be left uncropped along each tree row, and each year after the first this area should be increased by two feet on each side to allow for the extension of the tree roots.

In thinning, it is stated that each fruit requires 30-50 active leaves. This works out at about one apple per spur with half the spurs carrying no fruit. The comment is made that " beginning thinners should not look at the fruit on the ground."

H.B.S.M.

MYCOLOGY

Control of Parasitic Fungi by Antagonistic Organisms

Newhook[1] has shown that various bacteria isolated from dead lettuce leaves are antagonistic to *Botrytis cinerea* isolated from the same host. Strains of *Bacillus subtilis* group, a strain of *B. anthracis* type, and strains of *Chromobacteria* sp. and *Pseudomonas* sp. showed some degree of fungistatic action to a culture of *B. cinerea* on agar, on wounded lettuce leaves detached from the plant, and on wounded leaves of lettuce seedlings. In petri dishes all the strains tested were effective at 25 to 30°C. and the strains of *Pseudomonas* and *Chromobacterium* showed marked antagonistic activity at 4°C. On lettuce leaves, however, although some strains controlled the growth of *B. cinerea* at 25° to 30°C., they had little effect at 4°C. Both on agar and on lettuce tissue, growth of the bacteria caused a rise in the *p*H of the medium from 6.1 to 7.8-8.4. At this higher *p*H, growth of *B. cinerea* was almost negligible but the antagonistic action of the bacteria was due mainly to the production of antibiotic substances not to the *p*H factor. The mixed bacterial flora obtained from dead lettuce leaves showed as great or greater antagonism as that exhibited by most of the pure cultures of the test strains. Some spores of the test strain of *B. cinerea* gave rise to new strains, which were more resistant to the antagonistic activity than was the original culture.

In a second paper Newhook[2] discusses the antagonism of fungi and actinomycetes to *Botrytis cinerea*. The organisms used were isolated from dead lettuce leaves, those most frequently obtained being *Fusarium*, *Phoma*, *Cephalosporium*, and *Cladosporium* species. Many of the isolates showed some degree of antagonism to *B. cinerea* under control conditions. As with bacteria, most of the fungi raised the *p*H of the culture media, but, again, tests with buffered media showed that the antagonistic effect was not entirely due to this cause. When detached lettuce leaves were inoculated with pure cultures of several of the fungi and a suspension of soil from lettuce seedlings, germination of *B. cinerea* spores placed on the leaves at the same time or later was reduced or

inhibited. However, on leaves of living plants control of *Botrytis cinerea* was obtained only by prior inoculation with the soil suspension. The author suggests under field conditions some natural control of *B. cinerea* on lettuce is due to the antagonistic activity of saprophytes. The degree of antagonism is related to the amount of moisture present, which, in turn, depends on climatic factors and the position of the dead tissue on the plants. In field tests application of pure cultures of several antagonistic organisms at three-weekly intervals failed to control grey mould of the lettuce, and under the same conditions applications containing tetra-chlornitrobenzene increased the number of plants surviving, especially under cloches. Earthing up of the plants and planting in hollows instead of on ridges gave some control of the disease, possibly due to providing conditions favourable to microbiological activity on the dead leaves. *B. cinerea* was able to enter the soil from the roots of infected plants and also to pass from the roots of one plant to another. In spite of the antagonism shown by other organisms present in the soil, *B. cinerea* persisted over six weeks after the tops of infected plants had disappeared.

In a paper on the control of *Botrytis cinerea* on lettuce, R. K. S. Wood[3] discusses the results obtained by other workers on disease control by antagonistic organisms and describes his own experiments. On agar media a number of organisms showed pronounced antagonism to *B. cinerea* at 15°C. and at 21°C., but only a few (*Penicillium clavariaeforme*, *Pseudomonas* sp. 1 and 2, *Fusarium* sp. 1 and 2, and a suspension of seed bed soil) were also effective at 5°C. When several organisms were inoculated on to detached lettuce leaves before or at the same time as *B. cinerea*, a good control of the fungus was obtained at 20°C. At lower temperatures the degree of control was less, but even at 5°C. *Penicillium clavariaeforme*, *Fusarium* sp. 1, and the soil suspension suppressed development of *B. cinerea* to some extent. It was also demonstrated that the hyphae of *B. cinerea* did not penetrate through dead tissue previously inoculated by certain other organisms. Under frame conditions considerable control of *B. cinerea* was obtained by spraying the seedlings with suspensions of antagonistic organisms in 1 per cent glucose solution on three occasions. The most effective organisms used were *Pseudomonas* sp. 1., *P. clavariaeforme*, and *Fusarium* sp. 1. Wood considers, however, that the direct application of selected antagonists to lettuce plants is less likely to provide a practical method of control of *B. cinerea* than is the adoption of cultural methods which would encourage the natural colonization of dead lettuce leaves by saprophytes normally present in the seed bed.

Wood has also investigated[4] the antagonism of pure cultures of a number of bacteria, actinomycetes and fungi to *Rhizoctonia solani*. On soil abstract agar at 25°C. a number of organisms suppressed the growth of this fungus, but fewer showed any antagonism at 15°C., and at 5°C. effects were produced only by *Penicillium clavariaeforme*, *Pseudomonas* sp. 1 and 2, and a soil suspension. In greenhouse experiments when certain antagonists such as *Streptomyces* sp., *Penicillium clavariaeforme* and *Trichoderma viride* were added, together with *Rhizoctonia*, to sterile

soil two or three weeks before sowing the lettuce, considerable control of damping off was obtained. When unsterile soil was used in similar experiments the results were more erratic, and the same antagonists had little beneficial effect. In a field experiment green manuring and the addition to the soil of maize meal increased the stand of lettuce seedlings. Wood suggests that the practical control of the disease may lie in the addition of such amendments to the soil and the development of other cultural practices which may encourage microbiological activity in the soil during the summer months.

References

1. Microbiological Control of *Botrytis cinerea* Pers. I. The Role of *p*H Changes and Bacterial Antagonism. F. J. Newhook. *Ann. appl. Biol.*, 1951, **38**, 169.

2. Microbiological Control of *Botrytis cinerea* Pers. II. Antagonism by Fungi, Actinomycetes and Micro-Organisms Occurring in Soil Suspensions. F. J. Newhook. *Ann. appl. Biol.*, 1951, **38**, 185.

3. The Control of Diseases of Lettuce by the Use of Antagonistic Organisms. I. The Control of *Botrytis cinerea* Pers. R. K. S. Wood. *Ann. appl. Biol.*, 1951, **38**, 203.

4. The Control of Diseases of Lettuce by the Use of Antagonistic Organisms. II. The Control of *Rhizoctonia solani* Kuhn. R. K. S. Wood. *Ann. appl. Biol.*, 1951, **38**, 217.

H.E.C.

ENTOMOLOGY

Whither Insecticides? Galley, R. A. E. *Chem. & Indstr.*, No. 53, December, 1950

This paper was read before the Agricultural Group of the Society of Chemical Industry. The purpose of the paper was to survey the situation as regards insecticides with special reference to the future. The aim of research in insecticides was stated as " the control of insect pests with very little adverse effect on beneficial insects and other wild life ; without hazard to the operator and without damage to the host plant, food or animal ; and where appropriate, without risk to the final consumer of the produce ".

The present position concerning insecticides is reviewed, the importance of the introduction of DDT into Britain in 1942 is stressed and reference is made to the great variety of insecticides including BHC, which have followed. Search for new compounds has been particularly intensive in the U.S.A.

The most interesting developments are in the organo-phosphorus range of compounds such as HETP and parathion, which have led to those compounds which have been termed " agents for plant chemotherapy ". These compounds are capable of being absorbed through the roots and sometimes through the leaves of plants into the sap stream in which they are translocated and remain toxic for some time, particularly to sucking insects ; these compounds are now usually termed systemic insecticides.

A new line of great promise is that concerned with natural and synthetic pyrethrins. The natural product was found to be toxic more generally to various insects than the synthetic products ; but while the synthetic product was not so active against some insects as the natural product, it was more active against certain insects. In other words, the synthetic insecticide was more selective. It is to be hoped that systemic insecticides will also be found which will also be more selective, particularly in the direction of lower toxicity to mammals.

There is a growing tendency for dangerous compounds to be used for crop protection and some of these compounds, such as HETP and parathion possess the hazard of being absorbed through the skin, which was not a feature of the older insecticides. It is pointed out that some of these older compounds, such as lead arsenate and nicotine, are also far from being harmless. There is risk in the application of both classes of compounds unless the proper precautions are taken. While the view is put forward that there is no real objection to the use of dangerous compounds " provided the dangers are known and can be guarded against ", future work should certainly be aimed at the reduction of mammalian toxicity. As important as the mammalian toxicity is the wide range of the toxicity of many of the newer compounds to insects, resulting in serious reduction of beneficial insects.

A movement towards greater selectivity is clearly of first importance and an understanding of the mechanism of selectivity.

The least understood of the insecticides are the systemic insecticides, but they offer a new approach to insect problems and may provide striking advances within the next few years. The spraying problem will be much simplified, since it is unlikely that it will be found necessary to effect the same high degree of cover of the plant.

Rabbit Damage to Winter Corn. Gough, H. C. and Dunnett, F. W. *Agriculture*, 1950, **57**, 374-8.

Although it is well known that the rabbit is a serious pest of agricultural crops, the extent of the damage rabbits cause to winter cereals is not widely known. Gough and Dunnett have carried out a survey in East Anglia, and as a result, they estimate that at least £100,000 worth of winter corn was lost during a season as the result of grazing by rabbits. Attacks usually occur in fields near woods or rough country and are reported from December to April. Familiar as the damage is to most farmers, there are nevertheless many who remain sceptical.

The damage consists of a clean cut at right-angles to the blade of the leaf of the young plant and badly damaged patches appear bare from a distance. The damage may readily be distinguished from that produced by attacks of slugs, cutworms and leatherjackets. Bird damage sometimes resembles that caused by rabbits, but birds never feed regularly and systematically over a field.

It is pointed out that it is not easy to connect the number of rabbit droppings in a field with the amount of damage, owing to the uneven distribution of the population and the fact that " lavatories " are used ; visits at night showed numerous rabbits grazing such fields.

Small plots on fields were enclosed with 1½ in. mesh netting, 3 feet in height, and although the cages were not erected until late in the season, the plants within them grew away much more rapidly.

Rabbit damage does not always have an adverse effect on subsequent yields. Such factors as mild weather during the winter and dry summers and autumns, as they affect rate of breeding and alternative food supplies, will greatly influence the amount of damage. Late sowing, or sowing taking place under unfavourable conditions, are also important factors.

Plant counts were made in fields grazed by rabbits, and comparisons were made between the lightly grazed areas and those portions heavily grazed. The figures showed that the plant population may be reduced by as much as 80 per cent. Ripening of a seriously grazed crop may be delayed by 10 to 18 days.

Hazards from Insecticides. Barnes, J. M. *British Medical Bulletin*, 1950, **7**.

This paper reviews the general nature of the hazards from insecticides. While the potential hazards are the greatest during the manufacture of the active ingredients, it is pointed out that the firms concerned are well aware of the dangers, the number of people exposed to such risks are small and they are well protected.

The dangers are probably greater when the chemicals are passed on to manufacturing firms who formulate the various insecticides. The next point of danger lies with those applying the insecticides who may be skilled or unskilled. Despite the fact that they are often more skilled than other workers, those engaged in contract spraying are exposed to special risks, since spraying may occupy the whole of their working time for many weeks.

A third and more insidious danger, about which little is known, may be associated with the marketing of foodstuffs contaminated by insecticides. There is always the possibility that small quantities may be ingested over periods of years. The risk may not seem great when a single item of diet is considered above ; many items in the diet may be contaminated. The importance of acquiring such information is stressed.

The toxic properties of some typical insecticides are discussed.

The author states that those interested in the use of insecticides would do well to pay more heed to the possible risks to public health attending the use of certain insecticides. He also suggests that the best insecticides from the point of view of the consuming public would be chemicals highly active but unstable and readily decomposed into innocuous break-down products.

Wireworms. King, K. M., Arnason, A. P., and Manson, G. F. *Processed Publication Series Leaflet No.* 87, Department of Agriculture Science Service (Division of Entomology), September, 1948.

This paper is a useful review of the chemical control of wireworms under Canadian conditions; of liquid fumigants, ethylene dibromide (EDB) gives good wireworm control. Seeding or planting may take place a few days after treatment, a little longer being allowed where soils are cold. From 5 to 8 gallons per acre are used, depending on the heaviness of the soil, of the commercial material containing 20 per cent of the EDB; application is usually by dribbling the fumigant along the bottom of each furrow just before it is covered by the next plough-slice.

Dichloropropene mixture (DD) also gives a good quick control of wireworm. At least 16 gallons per acre must be used and 2-4 weeks allowed between treatment and planting. Results with benzene hexachloride (BHC) are also discussed and the limiting factor of tainting is emphasized.

Chlordane has given promising results, though often slower acting than BHC. Warm moist soil is best and applications just before planting are recommended. Tainting is not so noticeable as with BHC. 100-200 lb. of 5 per cent dust per acre are recommended.

Seed treatments with BHC and other chemicals are also mentioned.

L.N.S.

VIROLOGY

Nasturtium Mosaic, a Virus Disease of *Tropaeolum majus* L. in California. Jensen, D. D. *Phytopathology* (*Abstr.*), 1950, **40,** 967.

A virus disease of garden nasturtium *Tropaeolum majus L.* occurs in California, having symptoms previously confused with those produced in nasturtium by Tomato Spotted Wilt virus. Symptoms include veinlet-clearing of the youngest leaves followed by mosaic mottle of variable patterns and some crinkling of the leaves. Diseased plants are only mildly stunted. Symptoms first appear five to seven days after inoculation, the incubation period usually being three to five days shorter than that of Spotted Wilt virus in nasturtiums. The virus is readily transmissible by juice inoculation. It has a dilution end point between 1 : 20,000 and 1 : 30,000. The infectivity of the virus in fresh juice is destroyed by heating for 10 minutes at 55° C., but not at 50° C. Infectivity is retained after ageing *in vitro* for four days at room tempera-

ture. The virus apparently has a limited host range. It is readily transmitted by a number of aphids including *Myzus persicae* Sulz. which can acquire infection after five seconds on a diseased plant. (This may be the same disease recorded recently in this country. See this Review, No. 7, p. 130.)

Mosaic of Cymbidium Orchids. Jensen, D. D. *Phytopathology (Abstr.)*, 1950, **40,** 966.

A widespread mosaic disease of Cymbidium orchids is caused by a virus, and its incidence in commercial hybrids ranges from 15 to 70 per cent in California. The same disease is present in other parts of the United States and in plants imported from England and France. A disease with similar symptoms has been reported from Australia. Mosaic symptoms appear as small, faintly chlorotic streaks and patches on the new leaves about six weeks after infection. Subsequently the mosaic mottle becomes conspicuous and frequently is followed by necrotic spots, streaks and rings. The virus is readily transmitted by mechanical inoculation from Cymbidium to Cymbidium. It is a stable virus, retaining infectivity *in vitro* for at least seven days at room temperature. It remains infective in juice heated for 10 minutes at 60° C., but is inactivated at 65° C. The host range is limited and the insect vector has not yet been determined.

Particles, possibly Virus, isolated from Orchids. Gold, A. H. *Phytopathology (Abstr.)*, 1950, **40,** 965.

Two types of particles were isolated from orchids suffering from virus symptoms, and studied in the electron microscope. One of these, a sinuous rod, 19mμ in diameter by 500 mμ in length, occurred in Cymbidium plants with symptoms of Cymbidium mosaic. The other, a rod 28mμ in diameter and variable in length, was found in Cymbidium leaves having other virus-like symptoms and in " broken " flowers of Cattleya plants. Purified preparations of Cymbidium mosaic plants induced symptoms in one plant of two inoculated. No symptoms have developed from two plants inoculated with a preparation of the other rod-shaped particle.

The Infection of Plants by Viruses through Roots. Roberts, F. M. *Ann. appl. Biol.*, 1950, **37,** 385.

Roots of young tomato plants became infected when inoculated with Tomato Bushy Stunt, Tobacco Mosaic, and Potato X viruses. Root infections also occurred when these viruses were added to soil or culture solutions in which plants were growing. The viruses were sometimes localized around their initial entry points in roots ; sometimes they invaded the root system but not the shoots, and sometimes they produced full systemic infection of roots and shoots. In some experiments, but not

all, systemic infections were more frequent when the upper tap root or superficial roots were inoculated than when fibrous roots were inoculated. In both tomato and potato, virus X spread from diseased to healthy plants sharing the same culture solution if their roots were in contact, but not otherwise. Infection of the roots of potato plants by inoculation produced only one plant with virus-infected haulms, although several had infected tubers.

Aphid Migration and the Spread of Plant Viruses. Kennedy, J. S. *Nature*, 1950, **165,** 1024.

Many field and laboratory observations indicate that aphids are not attracted to their hosts from a distance and neither isolated hosts nor those in a crop should be regarded as the terminus of purposeful flights, but only as stopping places in a blind flow of migrants. Thus it cannot be assumed that winged aphids do not visit and feed on plants which they do not colonize. Their behaviour suggests that they might, in theory, be the sole vector for a crop they do not colonize. It is concluded that in an aphid species its ability to transmit a virus and the abundance and activity of its winged forms are more important for spreading viruses than its potentialities as a direct pest of a crop.

Studies on Two Aphid-transmitted Viruses of Leguminous Crops. Chaudhuri, R. P. *Ann. appl. Biol.*, 1950, **37,** 342.

Pea mosaic virus was transmitted by *Myzus persicae* Sulz., *Macrosiphum pisi* Kalt., *M. solanifolii* Ashmead, and *Aphis fabae* Scop., but not by *Hyperomyzus staphyleae* Koch. It is a " non-persistent " virus and it is most readily transmitted when vectors are fasted and then given a short infection feeding. Vector efficiency was not increased by increases in preliminary fasting beyond 15 minutes or with increasing infection feeding beyond 1 hr. Most aphids became non-infective within 15 minutes when feeding, but fasting aphids remained infective for 3 hr. Species that fed readily on the infected plants were less efficient vectors than those that did not. Seed set by infected plants produced healthy seedlings. Pea enation mosaic virus persisted in *M. persicae* and *Macrosiphum pisi* for more than 140 hr. ; its transmission was unaffected by preliminary treatments of aphids. No transmission was obtained until at least 4 hr. after aphids had left infected plants ; usually the " latent " period exceeded 1 day and its duration was apparently unaffected by the length of infection feeding.

The Spread of Virus Diseases to Single Potato Plants by Winged Aphids. Broadbent, L., Chaudhuri, R. P., and Kapica, L. *Ann. appl. Biol.*, 1950, **37,** 355.

Young potato plants in pots exposed in the open near plots of potatoes for limited periods at intervals during the summer, became infested with large numbers of winged aphids only during warm, calm and dry weather. Although visited by aphids during May and June, when much

of the spread of viruses occurred in nearby potato crops, few of the potted plants became infected. Most potted plants became infected in July when late aphids were leaving neighbouring potato crops. Widely different proportions of the exposed plants became infected in different years ; in two of the three years, many more plants were infected with virus Y than with leaf-roll virus.

Control of Yellows in the Marshall Strawberry. Campbell, Leo. and Breakey, E. P. *Phytopathology (Abstr.)*, 1950, **40,** 964.

In a plot containing approximately 35 per cent yellows, planted adjoining an old untreated field containing the disease, parathion dust gave 12.87 per cent suppression in the spread of yellows as compared with the untreated checks. Benzene hexachloride, methoxychlor, and rothane dusts were ineffective. In a plot containing 10 to 15 per cent yellows at planting time, and adjoining an old field containing yellows, which was dusted twice with parathion during the blossom stage and then ploughed under after harvest, the average percentage of yellows where benzene hexachloride, parathion, and tetraethyl pyrophosphate were used, was 9, 5, 13, 37, and 10.35 respectively. In an isolated plot containing a trace of yellows when planted, in which every tenth plant was replaced with one having yellows and removed after two months, 1.67, 0.72, and 0.47 per cent yellows was found at the end of the season where benzene hexachloride, parathion, and tetraethyl pyrophosphate, respectively, were used. Benzene hexachloride, parathion, and tetraethyl pyrophosphate were used as 1 per cent dusts. In each plot there was a positive correlation between the suppression of yellows and the aphis kill by each of the insecticides.

A Plant Virus that Multiplies in its Insect Vector. Black, L. M. *Nature*, 1950, **166,** 852-3.

Experimental evidence for the multiplication of two plant viruses in their insect vectors has already been published by Fukushi, Kunkel and Black. This note records briefly experiments with a new virus which are believed to leave no doubt about its ability to multiply in both its plant hosts and insect vector. The virus in question is the clover club-leaf virus which has been shown to pass through the egg of its insect vector, the leaf-hopper *Agalliopsis nevella* Say. On February 8, 1945, a virus-bearing female leaf-hopper was mated with a virus-free male and the pair caged on a lucerne plant. The experiments were continued for more than five years through twenty-one generations of insects grown only on immune lucerne without loss of infectivity. The dilution of the original virus, assuming no multiplication in the insects, would, at a conservative estimate, exceed $1 : 2.8 \times 10^{26}$.

Internal Browning of Tomatoes in Maryland. Cox, C. E., and Weaver, L. O. *Phytopathology (Abstr.)*, 1950, **40,** 870.

Internal browning of tomatoes has been recognized in Maryland and neighbouring states since 1945. It was found in five counties in Maryland

in 1949. Losses have been small due to the limited occurrence of infected plants and to the tendency of diseased plants to produce many normal fruits. There appears to be no difference in varietal susceptibility. Transmission tests from the tomato plants which gave fruits with internal browning, by grafting and inoculation, produced mosaic mottling in tomato plants and local lesions in *Nicotiana glutinosa*. In electron micrographs purified virus from *N. glutinosa* could not be distinguished from tobacco mosaic virus.

K.M.S.

SOILS

Root Production by Agricultural Crops on Arable Land and Grassland. Goediwaagen, M. A. J. and Schuurman, J. J. *Trans. 4th. Int. Cong. Soil. Sci.*, 1950, **2**, 28-31

A study of this problem has been carried out at the Agricultural Experimental Station at Groningen, Holland, from 1936 onwards. A brief summary of the methods used and the results obtained is given. The roots were weighed in an air dry condition. Most of the work was carried out on grassland. However, from their own work and that of other continental workers, particularly Gericke, they have arrived at rough approximations regarding cereal crops. They suggest that cereals produce a rather high amount of roots and stubbles in the top soil. Winter cereals yield a higher amount than spring cereals, oats as a rule giving the greatest amount among the latter and rye among the former. Variations are very considerable. The average amount of roots and stubbles of the grain crops in the surface soil was about 2,200 lb. per acre with a minimum of 1,400 lb. for spring barley and a maximum of 3,100 lb. for rye.

The root production of the perennial leguminous crops was found to be high. An average weight of roots and stubbles of nearly 5,500 lb. per acre was obtained for lucerne. Annual leguminous crops and other green manuring plants gave a much lower root yield, an average of about 800 lb. per acre. The roots produced by the tuber crops, beet and potatoes, were relatively low. The average root weights for potatoes was about one-seventh that of the average for the grain crops. Their determinations show that about 75 per cent of the root system of arable crops is concentrated in the surface soil (0-8 in.). The smaller contribution of the deeper roots is, however, considered to be important as a means of the enrichment of the subsoil in organic matter and possibly, also, in its effect in ameliorating its structure and permeability.

In general, grassland gave much higher root yields than those obtained for arable crops. For 15 fields of old grassland an average root weight

of 6,500 lb. per acre was found in the top 8 inches, this being 87 per cent of the whole root mass. On some fields more than 10,000 lb. root weight was found in the top 8 inches. The amounts of root weight varied considerably from field to field and year to year. That of young grassland is also high but generally lower than the older land and is less concentrated in the top soil.

Owing to the seasonal variation of the root system in grassland, due to the development of fresh roots and the decay of old roots, determination of the annual root production is not easy. Under Dutch conditions the total amount increases in the early spring up to May and after this month gradually decreases, reaching a minimum in the following winter. From values of seasonal variations it is suggested that the average amounts of roots produced annually by grass crops on mineral soils is about 5,000 lb. per acre.

From their own experience and the data given in the literature, the authors suggest that root production on grassland may to a certain extent be increased by improving the fertility of the soil. Thus the application of artificial fertilizers may cause an increase rather than a decrease in the amount of soil organic matter.

W.M.D.
R.W.

The Evaluation of Liming Materials for Agricultural Purposes. Smith, A. M., Comrie, A., and Simpson, K. *Analyst*, 1951, **76**, 58.

The Fertilizer and Feeding Stuffs Act prescribes that the Statutory Statement for burnt lime must give the percentage of calcium oxide present in the sample. The determination of this figure must be done by an analytical method which takes no account of any unburnt calcium carbonate or of any magnesium oxide or carbonate, and so may lead to the under-estimation of the value of the liming materials for neutralizing soil acidity or increasing the percentage of exchangeable calcium in the soil. Some limestones contain siliceous materials which are converted on burning to calcium silicates and these, though unaccounted for by the official methods of analysis, will often readily decompose in soil to reduce its acidity.

Although not an official test in this country, the determination of the Total Neutralizing Value of a liming material is becoming used frequently by analysts as an extra check on its value for soil improvement. It is a simple and rapid test, consisting of measuring the quantity of 0.5 N hydrochloric acid which is neutralized on boiling 50 ml. of it for 3 minutes with 0.5 grm. of the material. The advantage is that it takes into account the carbonates and oxides of calcium and magnesium.

The authors of this paper have compared the rating of a number of liming materials as given by their neutralizing effect on soils, Total Neutralizing Value (T.N.V.), and CaO content determined by ammonium

chloride, concentrated acid or the official sugar method. For the first method a series of flasks each containing 20 grm. soil, 50 ml. boiled distilled water and varying known quantities of liming material were shaken for several days until equilibrium was reached so that neutralization curves could be plotted. The comparisons show that all methods except the sugar method gave good agreement with the neutralizing effect on soils. The T.N.V. method is the simplest to carry out and is applicable to a wide range of materials such as burnt lime, shell sand, or ground limestone.

Pot and field experiments over a wide range of soils using barley, swedes, turnips and beet have shown that ground burnt lime, ground limestone and waste limes applied in quantities related to the T.N.V. of each have had effects in increasing the *p*H values of soils in good agreement. In view of the greater difficulty of obtaining even incorporation of materials of varying degrees of fineness of grinding with soil in the field than with soil in pots, these results are very satisfactory and indicate the practical value in advisory work of the T.N.V. value of liming materials.

J.B.E.P.
W.M.D.

Nitrogen for Grass. *Jealott's Hill Bulletin No.* 9, 1950.

Halliday and Sylvester point out in their introduction to this Bulletin that the area under grass in the United Kingdom is nearly 18 million acres (excluding rough grazings). This amount of grassland, it has been estimated, will provide 45 per cent of the total starch equivalent and 60 per cent of the total protein equivalent grown in the country.

The average yield of 10-12 cwt. starch equivalent per acre is decidedly low compared with the Netherlands 1939 average of 20 cwt. They suggest that this increased output is due to the fact that the Dutch treat grass *as a crop* and apply fertilizers accordingly; thus their average application of nitrogen to grassland is equivalent to 2 cwt. " Nitro-Chalk " per acre annually compared with 0.13 cwt. to permanent grass and 0.25 cwt. to leys in the United Kingdom. The first essential for good output from grassland is a high level of fertility which means adequate use of fertilizers, and they point out that there is sufficient evidence to show that in the presence of adequate phosphate, potash and lime, both grazed and conserved grass respond well to nitrogen.

General Considerations. The productivity of grassland in the British Isles is determined largely by (i) the soil moisture supply, (ii) soil temperature, (iii) the lime status of the soil, (iv) the botanical composition of the sward, and (v) the supply of available plant foods, particularly nitrogen, in the soil. In regard to the last factor, they point out that grass is a heavy feeder and removes large quantities of plant nutrients from the soil. The losses vary with the type of animal grazing the herbage and are much greater when the grass is cut and removed from the field. Thus, the quantities of major plant foods cal-

culated in cwt. per acre removed in a grass crop of 3 tons dry matter per acre are estimated by Hamilton[1] as follows :

Fertilizer	Grazed		Cut and Sold off the Farm
	Adult fattening Cattle	Dairy Cows and Young Stock (partly eaten indoors as hay or silage)	
"Nitro-Chalk" (15.5 per cent N)	0.6	5.8	10.8
Superphosphate (18 per cent P_2O_5)	0.14	1.0	3.0
Muriate of Potash (50 per cent K_2O) ...	0.24	1.4	4.2
Lime (54 per cent CaO)	0.10	0.8	2.2

Estimating the Response to Fertilizer Treatment. The difficulty of obtaining an accurate measure of response with fertilizer trials on grass is stressed, e.g., such factors as the time of year when increased yields are obtained, the feeding value of the extra grass and the effect of the treatment on the sward are all important. The various techniques used for assessing the value of grass as hay, silage, dried grass and as grazing are given and their limitations discussed.

Hay. Many manurial trials have been carried out showing the effect of nitrogen in increasing the yield of hay. Thus, at Rothamsted [2] over a period of 80 years, the use of 0.4 cwt. nitrogen per acre per annum as nitrate of soda, with phosphate and potash, gave an average increase of 10 cwt. of hay as compared with plots receiving only phosphate and potash. At the Herts Institute of Agriculture [3] over a period of 3 years, the average yield of hay without nitrogen was 45 cwt., with 0.3 cwt. nitrogen as sulphate of ammonia 56 cwt. and with 0.3 cwt. nitrogen as "Nitro-Chalk" 54 cwt. per acre. Recently Yates and Boyd[4], from the results of many experiments, have calculated the response of hay crops to fertilizers, and they state that dressings of 0.25 cwt. nitrogen per acre increase the yield of seeds hay by 11.6 cwt. and of meadow hay by 8.8 cwt. per acre.

Many experiments have shown that a late top dressing of nitrogenous fertilizer (0.2-0.4 cwt. nitrogen per acre), applied 10-20 days before cutting, increases the crude protein content of the dry matter of hay by about 1-3 per cent, thus increasing the protein equivalent by 10-30 per cent. In addition, the late top dressing improves the growth of aftermath.

Silage. The results of 11 experiments carried out by Jealott's Hill[5] staff show that in grass for silage given 0.2-0.4 cwt. nitrogen per acre 7-14 days before cutting, there is an appreciable increase in the crude protein content of the dry matter, namely, from 11.4 to 13.0 per cent for 0.2 cwt. nitrogen, and to 14.6 per cent for 0.4 cwt. nitrogen, respec-

tively. If nitrogen is applied 3-4 weeks before cutting, the yield as well as the quality is improved.

Dried Grass. As stated earlier by Hamilton[1], when several cuts of grass are taken from a field for drying, large amounts of nutrients are removed, and these losses must be made good if the yield and quality of the product are to be maintained. At the Herts Institute of Agriculture[3] over a period of 4 years, the use of 2 cwt. sulphate of ammonia per acre per annum on permanent pasture cut 3 or 4 times during the season, gave an average increase of 7 cwt. of dried grass, i.e., the average yield was increased from 50 to 57 cwt. per acre. Similar increases have been obtained in many trials carried out at Jealott's Hill[6].

Trials at the Hannah Dairy Research Institute[7] have shown that grassland responds well to heavy dressings of nitrogen (up to 2.7 cwt. nitrogen per acre as " Nitro-Chalk "), and that when supplemented by phosphate and potash, yields of 4½ tons per acre of dried grass have been obtained over a period of years. On plots receiving complete manure including the heavy nitrogen dressings, clovers were severely reduced but there was an increase in the better grasses such as ryegrass and cocksfoot.

Early Bite. A pasture containing a high proportion of early growing grasses such as ryegrass and cocksfoot can be grazed about 2 weeks earlier than usual if it is top-dressed with nitrogen fertilizer (0.2-0.4 cwt. nitrogen per acre) in February or March.

Rotational Grazing. Experiments carried out during 1929-31[8], in which plots were rotationally grazed by cows and " followers ", showed marked increases in herbage from the application of 0.1 cwt. nitrogen per acre as sulphate of ammonia in late February and after each three-weekly cut (except in 1931 when N was given every 6 weeks). On an average, the increases were 13.6 cwt. dry matter per acre in 1929, 13.4 cwt. in 1930, and 9.8 cwt. in 1931. Quality was also improved resulting in an average increase of 5 cwt. crude protein per acre.

Rationed Grazing. To obtain the maximum return from pastures which are intensively manured, it is important to utilize the grass as it grows ; this can be achieved only by the use of heavy stocking for short periods, or " on-and-off " grazing as it is sometimes called. To reduce wastage of herbage by soiling and trampling to a minimum, an electric fence should be used, so that each day the herd has access only to an area sufficient for that day's needs. Experience in the Netherlands and the results of preliminary trials at Jealott's Hill indicate that rationed grazing improves herbage utilization by 15-30 per cent.

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J.E.W.
W.M.D.

MACHINERY

Survey of Power on the Land. Cashmore, W. H. *J. Fmrs' Cl.*, Pt. 7, 1950.

In a broad survey of the progress of mechanization in Britain, the main subjects discussed are grass conservation, grain harvesting, root harvesting, the organization of farm work, and general design of farm machinery. The section on organization includes reference to the advantages of what is called the " batch system," whereby an individual operator does the complete job, even though this involves several distinct operations (e.g., loading, transport and unloading of silage). For example, the equipping of a medium-powered tractor with a hydraulically operated front loader and an easily attached mechanical spreader makes farmyard manure handling an efficient one-man job, and in a similar way, the buckrake enables silage-making to be mechanized in one or more one-man units. The advantages of such systems are given as (1) only one man and one machine is delayed by any breakdown; (2) low initial capital outlay; (3) high output per man hour per unit of capital outlay; (4) single units are suitable for small farms, and the same equipment is satisfactory for larger farms if used in groups, thus leading to a big demand for a single type of machine.

In connection with general design of machinery, it is observed that (1) small farms do *not* require scaled-down implements; (2) partial mechanization of complex operations may sometimes be the best solution; (3) there is a future for multi-purpose machines, e.g., a root harvester which, with a little modification, will handle swedes, turnips, potatoes, and previously-topped sugar beet; (4) standardization of row-widths on individual farms, and a measure of simplification of crop rotations, can minimize mechanization problems, especially on small farms.

Labour in Silage Harvesting. Baker, Vernon. *Scot. J. Agric.*, 1950, **30,** 89-94.

This article gives an account of a study of silage-making on 27 farms near Aberdeen ; 13 of the farms used hand-loading methods, 13 used mechanical loaders and one a buckrake. The methods of study were similar to those adopted in the N.A.A.S. 1948 Investigation, and the results obtained are similar to the findings of the earlier work, where the sample was larger and the farms were more widely spread. Since, however, the Scottish enquiries were all carried out within a small area, it was possible to carry a little further the investigation into the *causes* of the differences between various methods of organization. The conclusion was reached that the wide variations in labour efficiency could usually be directly related to the way in which the job was organized—i.e., to something which is within the control of the individual farmer. Among the findings are the following :

Green-Crop Loaders. Good results were obtained in crops of 5-6 tons per acre by taking one 5 ft. swath at 2 m.p.h. The chief source of lost time was badly organized transport.

Transport. It is observed that with two waggons circulating between a field gang and a silo gang " the two places together are bound to be without a waggon for periods which in total can never be less than the total haulage time ".

General Organization. Among the practical solutions of the transport difficulty mentioned above, both the use of additional trailers, with tractorless unloading where necessary, and also the use of small, " fully-circulating " gangs were found advantageous. (The fully-circulating gang does not, of course, save any transport time, but has some physical and psychological advantages.)

With one green-crop loader and only two tractors and trailers available, it was found wasteful to employ a gang of more than five men.

Only one case of use of a buckrake was included in the study, and this confirmed the now widely appreciated advantage of a piece of equipment which ensures that even if the operator through some mishap wastes his own time, he does not waste that of several other people.

Farm Machinery Developments in Germany : Tractors.

The D.L.G. Exhibition at Frankfurt in June, 1950, permitted a comprehensive survey of some recent German developments, and these are reported in *Osterreichische Landtechnik*, " Landmaschinen in Frankfurt am Main ", Heft 7, July, 1950, 191-8 A number of articles giving details of tractors, mounted implements, tractor engines, etc., are included in *Landtechnik*, Heft 14, July, 1950, p. 500. Practically all German tractors have Diesel engines, and single-cylinder models are common in the smaller sizes. The modern Lanz tractors dispense with the blow-lamp starting which was characteristic of earlier models,

some of which were imported into Britain. Most manufacturers now make a small 4-wheeled model of about 16 B.H.P. or less, and these are usually made as simple and cheap as possible, because the average small farmer has little capital to spare, and labour in the Western zones is fairly plentiful. The mounted implements which are now rapidly becoming available for use with the small tractors are, in consequence, usually raised and lowered by hand levers rather than by hydraulic lifts. Some manufacturers offer a cheap mechanical lift.

The development of mounted implements is, on the whole, less advanced than in Britain, and there is a multiplicity of linkage designs which makes British linkage standardization look a comparatively simple problem.

Several 4-wheel-drive tractors are manufactured, and the official K.T.L. leaflet *Schlepper, Ja, aber Welcher?* shows that they are looked on with some favour. Nevertheless, the German 4-wheel-drive machines have yet to prove themselves in competition with a vast preponderance of machines of the conventional rear-wheel-driven type.

Various types of half-tracks are being tried, and one of the most practical-looking examples is the Hülle, which bolts straight on to the normal wheel studs and can, it is claimed, be interchanged with the wheels in 20 minutes. Each half-track consists of a central small sprocket and a beam carrying a number of track rollers, with a chain track of the Bren carrier type. This half-track is at present designed for use on relatively low-powered tractors, and may well be satisfactory for such machines; but its obvious mechanical shortcomings seem likely to prevent its application to powerful tractors.

A feature of practically every German wheeled tractor of up to about 40 H.P. is the provision of a drive and mountings for a side-attached mower, and it must be admitted that this is the most sensible place to put the cutter-bar, since apart from having the knife where it can be easily watched, it leaves the normal drawbar free for other work.

In addition to the usual types of small two-wheeled tractors with connections to a 2-wheeled trailer or to directly coupled implements, there are small tractors with front wheel drive and rear wheel steering, but the disadvantages of this arrangement seem to outweigh any advantages. A single-wheel driven tractor, which has the engine mounted inside and alongside the large drive wheel, and is connected by a swivelling pivot to a two-wheeled frame which carries the tools, has some attractions. The tractor can turn through a full circle, so does not need a reverse gear, and can either pull or push the equipment according to need.

C.C.

NEW THINKING ON OLD PROBLEMS

It is proposed from time to time to publish short accounts of interesting methods, or "short cuts," which have proved successful in saving labour or other costs. All officers are invited to submit contributions.

Mr. Charles Turner, Assistant County Agricultural Officer (Advisory) Bucks, has contributed the following notes on some methods of catch cropping and rotation, aimed at reducing costs of production.

The growing of crops for consumption in situ *is an obvious method of reducing costs of feedingstuffs and labour. Thought has, therefore, been given to the planning of rotations to include broadcast crops (particularly Italian ryegrass and rape) which could extend the grazing season and be cheaply grown and utilized.*

After Early Potatoes

It is the practice in some areas to sow Italian ryegrass either alone or with rape after removal of the potato crop. Broadcasting Italian ryegrass and rape on top of the growing potatoes *before* spinning out the crop proved successful in Bucks last year.

No time was spent on cultivations and full advantage was taken of moist soil conditions and consolidation by field traffic immediately after spinning. The mixture was broadcast each morning over the area of potatoes to be lifted on the day in question. The first sowing was made in late July, and by mid-October the crop of greenstuff was around 5 tons per acre. Given normal lifting in June a much higher yield could be expected.

Curiously enough, the crop did not germinate in narrow uneven strips though sown in ridges, and grew through the haulm as a level sward.

Italian Ryegrass in Winter Cereals

Three or four pounds of Italian ryegrass are sown along with the winter cereals, and by the time the grain is harvested the ryegrass has shed its seed. This usually gives a complete take, and a heavy crop is available the following spring for silage or grazing. The sward can then be ploughed and broadcast with kale. On one farm, where the turning out time had previously been May, a 15-acre field was providing 2½ tons of greenstuff on March last and carrying 45 mature cattle. The limiting factor has not been the amount of growth in early March, but the condition of the land as regards poaching.

On another (6-acre) field, used for silage, the yield was 7 tons per acre in late April, with a second cut five weeks later, giving a total of 9 tons per acre of silage. Adequate time was left for a brassica crop or bastard fallow.

Italian Ryegrass and Rape as a Pioneer Crop on Breaking up Old Turf

As soon as conditions in spring allow, a mixture of 18 lb. ryegrass and 2 lb. rape is combine-drilled with a liberal amount of fertilizer.

This quantity of rape should not be exceeded, as the ryegrass may be smothered. A further dressing—2 cwt. of nitrogenous fertilizer—is given when the plants are 2-3 inches high. This sowing provides high-quality summer keep when most wanted, i.e., from June to September. Last year a crop of 10 tons per acre was available ten weeks after sowing.

Summer grazing largely kills off the rape, but very early the following spring a crop of pure ryegrass is available for feeding or ensiling. The field can then be reseeded without a cover crop or broadcast with kale for winter use.

Charles Turner.

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